THE

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY

OF ENGLAND.

VOLUME THE FOURTEENTH.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1853.

These experiments, it is true, are not easy; still they are in the power of every thinking husbandman. He who accomplishes but one, of however limited application, and takes care to report it faithfully, advances the science, and, consequently, the practice of agriculture, and acquires thereby a right to the gratitude of his fellows, and of those who come after. To make many such is beyond the power of most individuals, and cannot be expected. The first care of all societies formed for the improvement of our science should be to prepare the forms of such experiments, and to distribute the execution of these among their members.

Von Thaer, *Principles of Agriculture.*

London:—Printed by William Clowes and Sons, Stamford Street, and Charing-Cross.

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APPENDIX.

PLATES.

DIRECTIONS TO BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the *end* of each volume of the Journal, excepting Titles and Contents, which are in all cases to be placed at the *beginning* of the Volume: the lettering at the back to include a statement of the *year* as well as the *volume;* the first volume belonging to 1839-40, the second to 1841, the third to 1842, the fourth to 1843, and so on.

In reprints of the Journal, all Appendix matter (and in one instance an Article in the body of the Journal), which at the time had become obsolete, were omitted; the Roman numeral folios, however (for convenience of reference), being reprinted without alteration in the Appendix matter retained.

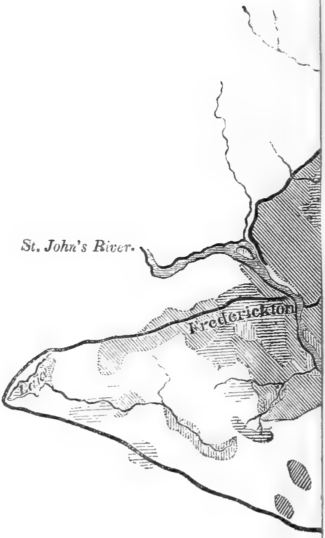
MAP

TO ILLUSTRATE THE

RELATIONS OF GEOLOGY TO A

IN

NORTH-EASTERN AM



St. John

Soils No. I

Soil . .

Soil . .

Soil . .

Bogs and S

JOURNAL

OF THE

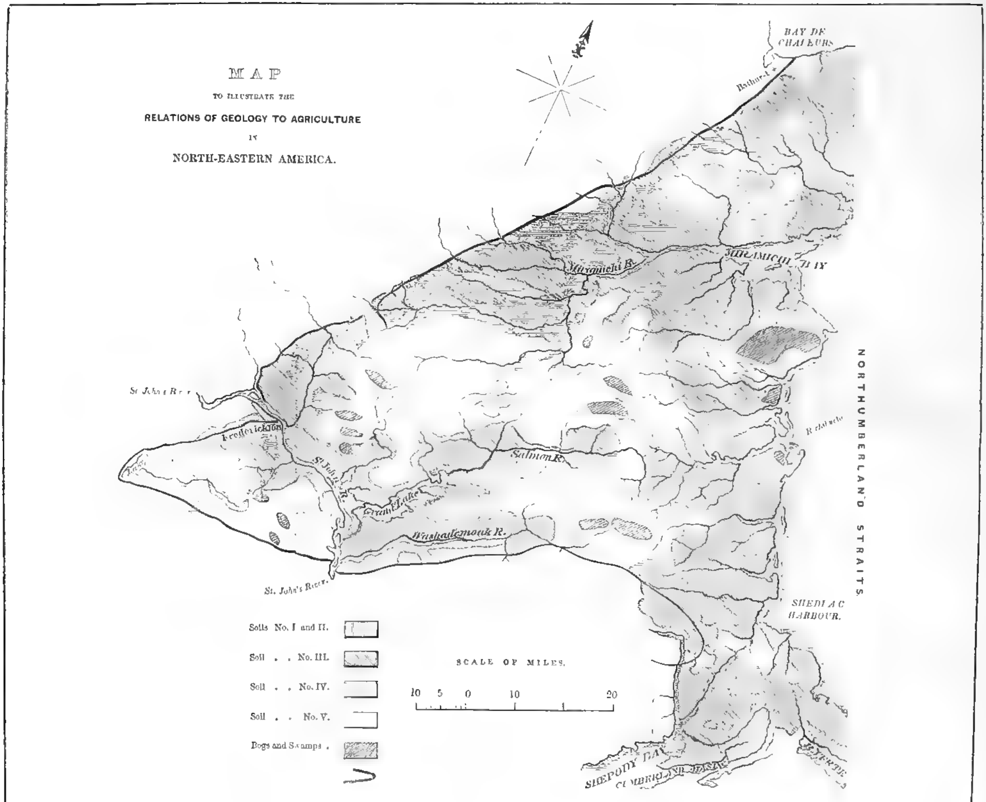
ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*Relations of Geology to Agriculture in North-Eastern America.* No. II. By JAMES F. W. JOHNSTON, F.R.S.L. & E., Hon. Member of the Royal Agricultural Society.

III. *Relations of Geological Structure to Agricultural Capability in the Province of New Brunswick.*—The examples of a close relation between geological structure and agricultural capability, which I introduced into the preceding part of this paper,* were interesting to the English reader chiefly in their purely scientific and economical bearings. Referring to the Atlantic border of the United States, and to the interior of the State of New York, they would come home, if I may so express myself, to few among ourselves as a matter of directly personal concern. It will be somewhat different as regards the example I am now about to submit. It is drawn from one of our own British provinces, where many of us have friends and relatives, and where wide unoccupied lands exist, to which we may emigrate without either abandoning our loyalty or giving up our connexion with the homes of our fathers.

The province of New Brunswick contains an area of 18 millions of acres; much of this is still covered with forests, and many districts still unexplored even by the lumberer. As represented in the geological maps hitherto published, its central part forms an extensive coal-field, bounded on the north by a riband of granitic and of old metamorphic and slate rocks, which runs diagonally—or in a north-east and south-west direction—across the whole province. On the south and south-west it is bounded along the shores of the Bay of Fundy by a belt of slate rocks of uncertain age, altered and hardened by extensive masses of hard, intrusive trap, which give an inhospitable and uninviting character to the region over which they extend. This coal-field occupies about one-half of the whole area of New Brunswick; and, as it is situated in the central part of the province, the rocks

* See this Journal, vol. xiii. Part I.


MAP
TO ILLUSTRATE THE
RELATIONS OF GEOLOGY TO AGRICULTURE
IN
NORTH-EASTERN AMERICA.
BAY DE CHALEURS
Bathurst
Miramichi R.
MIRAMICHI BAY
NORTHUMBERLAND STRAITS
St. John's River
Fredericton
St. John's R.
Salmon R.
Grand Lake
Washademoak R.
St. John's River.
SHEDIAC HARBOUR.
SHEPODY BAY
CUMBERLAND BASIN
Soils No. I and II.
Soil . . No. III.
Soil . . No. IV.
Soil . . No. V.
Bogs and Swamps .
SCALE OF MILES.
10 5 0 10 20

of which it consists impart their prevailing physical characters to the soils of this large portion of the colony.

It may be said with truth that the extensive prevalence of this coal-field in New Brunswick forms alone a striking illustration of the close natural connexion which exists between geological structure and agricultural capability. Of every extensive coal-field this might, to some extent, be said; but there are two circumstances in connexion with the coal measures of New Brunswick, which in an especial manner determine the agricultural relations of the soils which rest upon them.

The *first* is the chemical nature of the numerous beds of rock of which this coal formation consists. These are, for the most part, grey sandstones, sometimes dark and greenish, and sometimes of a pale-yellow colour. The siliceous matter which they contain is cemented together or mixed with only a small proportion of clay (decayed felspar principally), so that when these rocks crumble, which they readily do, they form light soils, pale in colour, easily worked, little retentive of water, admitting therefore of being ploughed early in spring and late in autumn; but hungry, greedy of manure, liable to be burnt up in droughty summers, and less favourable for the production of successive crops of hay.

Of course, among the vast number of beds of varied thickness which come to the surface in different parts of this large area, there are many to which the above general description will not apply—some which contain more clay and form stiffer soils; and some which, though green or gray internally, weather of a red colour, and form reddish soils: but lightness in texture and in colour forms the distinguishing characteristic of the soils of the whole formation. The generalization drawn from this single fact, therefore, gives us already a clear idea of the prevailing physical character of the soils over a large portion of the province, and illustrates the nature of the broad views which make the possession of geological maps so valuable to the student of general agriculture.

In other countries, as in England and Scotland, the coal measures contain a greater variety of rocks than is found over the carboniferous area of New Brunswick. They are distinguished in our island by the frequent recurrence of beds of dark-coloured shale, often of great thickness, which form cold, stiff, dark-coloured, poor clays, hard to work, and, until thoroughly drained, scarcely—except in rare seasons—remunerating the farmer's labour. Numerous sandstones do indeed occur, producing poor, sandy, and rocky soils; but it is the conjoined presence of the cold clays and the poor sands, which, in the midst of their mineral riches, have caused large portions of the counties of Durham and Northumberland to remain among the

least-agriculturally advanced and least-productive parts of the low country of Great Britain.

The *second* circumstance by which the agricultural relations of this portion of New Brunswick are determined, is found in its general physical conformation. It is distinguished by a general flatness of surface: it undulates here and there, indeed, and is intersected by rivers and occasional lakes; but it consists for the most part of table-lands more or less elevated, over which forests, chiefly of pine-timber, extend in every direction. This general flatness is owing to the small inclination of the sandstone strata on which the country rests, and to the small number of striking physical disturbances to which, as a whole, they have been subjected. These level tracts of land are not unfrequently stony, covered with blocks of grey sandstone of various sizes, among which the trees grow luxuriantly, and from among which the settler may reap a first crop of corn, but which almost defy the labour of man to bring the land into a fit condition for the plough. It is chiefly on the borders of the coal-field, however, that these stony tracts occur, as if the disturbances, to which the neighbouring rocks have in many places been subjected, had broken up the edges of the sandstone strata, and scattered their fragments over the adjoining surface.

A characteristic feature which results from this physical flatness is the occurrence of frequent bogs, swamps, carriboo plains, and sandy barrens. The waters which fall in rain or accumulate from the melted snow rest on the flat lands, fill the hollows, and, for want of an outlet, stagnate, causing the growth of mosses and of plants of various other kinds, to which such swampy places are propitious. Thus bogs and barrens, more or less extensive, are produced, and these greatly modify the natural agricultural relations of the surface.

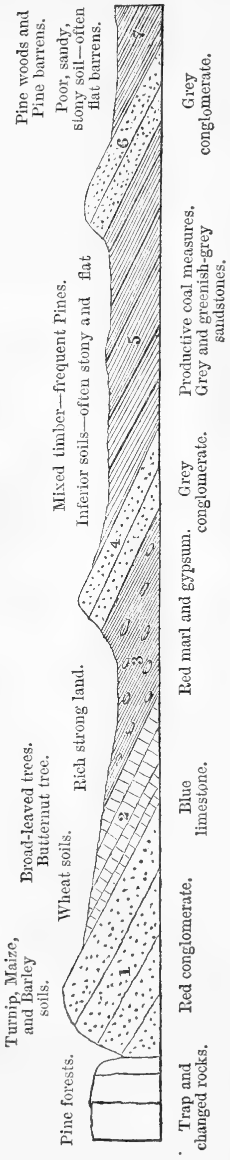
Thus the geological age, the chemical composition, and the physical disposition of this coal region, in reality appear almost equally to conspire in producing the peculiar general agricultural character of the central half of the province of New Brunswick. To this conjoined influence of important modifying causes I shall again advert before the close of the present article.

But New Brunswick also presents examples of the most striking and immediate dependence of agricultural value upon geological structure alone. On the outskirts of the coal-field, and rising up from beneath its edges, appear red sandstones and red conglomerates, associated with limestones, red marls, and gypsum. These give rise to soils of a remarkably fertile character, in the midst generally of scenery of a most picturesque description. In such localities rock and soil so closely accompany each other, that the most sceptical is compelled to admit that the

change in forest trees, in character of soil, and in nature of rock, are at once simultaneous and determined by a common cause.

The following section (No. I.) gives an idea of the way in which these rocks occur in connexion with the coal measures, and of the kind of soils which they respectively form:—

No. I.



The section commences on the left with the trap and altered rocks which bound the coal-field towards the south, as at the head of Belleisle bay, or on the Hammond river, about twenty miles from the town of St. John. On these rocks scanty soils are found, and the gloom of the narrow-leaved forest is rarely broken by the intrusion of the more cheerful beech, the oak, or the maple. But on the rounded hills of the red conglomerate (1),—which in Albert county remind the English traveller of the hills of our own Monmouthshire—broad-leaved forests of various trees cheer the eye, while the free and open soils which rest on them, though sometimes too gravelly, yet admit of being cultivated along steep slopes till the waving corn crowns the very tops of the hills. In the beautiful Sussex vale—justly the boast and pride of the province—and in some of its tributary valleys, the eye recognises with pleasure the features, both physical and agricultural, which are familiar in the red sandstone slopes of Strathmore, in the richly-farmed red sandstone fringe of Sutherland, and where a tillage hardly to be surpassed crowns the hills of Wooller, and accompanies the Northumbrian tourist to the foot of the Cheviot hills.

Over the red conglomerate (1) lies the blue limestone (2). On this rock the soil is sometimes thin, and, like our own blue limestones, the rock breaks out in some places into abrupt cliffs and naked slopes. Generally, however, it is covered with soils which are easily brought into culture, and are especially favourable to the growth of wheat. Of the native forest trees of North America, the white

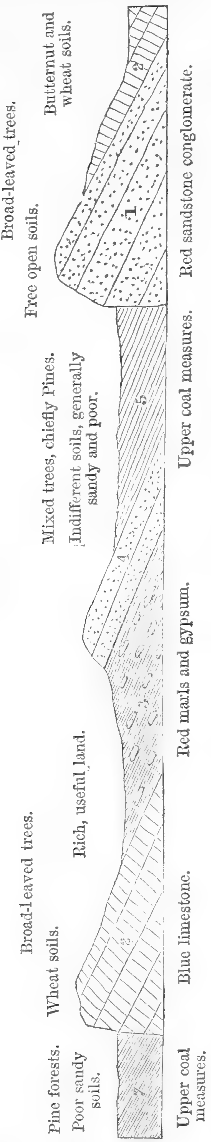
walnut (*Juglans cinerea*)—or Butternut, as it is called from its large oily nut—is one of those which appear to delight in calcareous soils. It is not known in the woods of Nova Scotia, but it occasionally abounds on the blue limestone ridges of New Brunswick. The *Butternut ridge*, the seat of a thriving settlement, about eight miles north of the Sussex vale, derives its name from having been originally covered with these trees. It consists of the blue limestone lying between the red conglomerate (1) on the one hand, and the red marls (3) on the other, and the settlement owes its existence altogether to these happy geological conditions. The explorer of still untrodden regions, from a distance of many miles, sees the setting sun in summer playing among the broad leaves of the butternut, or marks their peculiar autumnal tints when winter approaches, and records at once that good land exists on the spot, and a place desirable for settlement. The geologist may with almost equal certainty pronounce that there also limestone rocks abound, and near them in all probability the red rocks represented in our section.

Above the blue limestone rest thin beds of soft red marl, in which occur deposits of gypsum often of great extent and thickness. The softness of these beds has caused them to crumble readily and to form deep soils, and has also exposed them to be washed away by the rains and by the currents of water which in ancient times flowed over them. Hence the surface, where these rocks prevail, is of an undulating character, or it is scooped out into valleys of greater or less depth and breadth as is represented in the section. The soil is strong and rich, and in its natural state is covered with broad-leaved trees, where it is not oversaturated with water. When cleared, it yields excellent crops of wheat, and when laid sufficiently dry by arterial drainage, or by smaller conduits, it becomes fitted for almost every crop to which the climate is propitious. I mention arterial drainage, because the same soft character of these rocks which has led to the scooping out of valleys, has also caused the production in many places of flat plains possessing little natural inclination or outfall, and on which the waters from springs and rains and melting snows continually rest. Such places are covered by swamps or stunted forests of youthful pines. They can be laid dry and fitted for agricultural labour only by drainage operations, sometimes on a large scale, and such as in the present partial settlement of the colony, and while abundance of dry unoccupied land still remains in the market, are not likely to be undertaken either by individual proprietors, or at the expense of the provincial authorities.

To the red marls with gypsum succeed the grey conglomerates and sandstones of the coal measures (4, 5, 6, 7), of which I have

already spoken, as giving the general character to the agricultural capabilities of the central part of the province of New Brunswick. And with these rocks, as is shown in the section, the comparatively-poor soils to which they give rise succeed to the rich and productive soils of the red marls which lie below them.

No. II.



It does not always happen that the whole series of the rocks above described (1, 2, 3) is seen together in the same locality. While passing over the poor soils of the upper coal measures (7), the traveller may all at once be arrested by the blue limestone (2), and beyond it may come upon the beautiful rich soils of the red marls and gypsum, and after crossing these may find himself again among the flats and pine forests of the coal measures (4, 5, &c.). This is shown in the section No. II., in which the several rocks are numbered as before.

This section represents the blue limestone (2) as rising up and abutting against the upper coal measures (7); an effect produced by one of those disturbances from beneath, to which, as I have said, the edges of the coal-field have in many places been subjected. To this limestone succeed, towards the right, as in the previous section, the red marl and gypsum rocks, with the good soils they invariably produce, and beyond these come on again the indifferent soils of the lower coal measures. Further to the right again I have represented the red sandstone conglomerate (1) as reappearing in immediate contact with the lower coal measures (5), and producing consequently another sudden transition from an inferior to a superior quality of soil. Such transitions frequently recur along the southern and eastern skirts of the coal-field, and they are almost invariably to be connected with the direct and visible presence of these red and limestone rocks. Although, therefore, the presence of each of the red rocks and of the limestone is not always to be inferred from the discovery of any one

of them, yet two things are almost certain in this province—*first*, that wherever one of these three rocky formations comes to day, good land and broad-leaved trees will be met with; and *second*, that the best land in the southern half of the province, and the best-peopled settlements, are almost invariably situated upon these rocks; and at the same time the transitions are so sudden as to leave no doubt, on any observing mind, that upon the change in the geological structure alone are the changes in soil dependent.

The reader who is least familiar with the mode of settling a new country will readily understand that it is usual, in every district, to select, occupy, and cultivate the best and richest land first, provided it be equally accessible. He will understand it, therefore, to be in the natural course of things that many of the oldest and best settled agricultural districts in New Brunswick are situated upon the rocks which I have described.

But in speaking of fertility in a colony which, in the minds of many in this country, is associated with the idea of long winters, deep snows, and cold of intense severity, it may not be out of place to specify, in intelligible terms, the amount of productiveness which this fertility implies. By this means also a practical idea will be conveyed of the value of the province to the farming emigrant. During my stay in New Brunswick I collected a valuable body of special information, in which I was much assisted by the provincial authorities, in reference to the actual produce per acre of the cultivated land throughout the province. The average of the numerous returns obtained from practical men gave the following as the yearly produce of land per imperial acre throughout the whole of New Brunswick:—

Wheat . .	18 bushels	Buckwheat . .	28 bushels.
Oats . . .	33 ,,	Indian corn . .	36 ,,
Rye . . .	18 ,,	Potatoes . . .	6 tons.
Barley . .	27 ,,	Turnips . . .	11½ ,,

We are not to compare these averages with those of our own skilfully cultivated, well-manured, and generally high-farmed country, but with the yield of land in other parts of North America, if we wish to form a fair estimate of the comparative position of New Brunswick as an agricultural country. Now, leaving out New England, in which the soils are generally of a less rich description, we may select New York, Ohio, and Upper Canada, as among the most highly-esteemed regions of North America, in an agricultural sense. The following table exhibits the average produce of land in these several regions compared with that of New Brunswick:—

	New Brunswick. Bush.	New York. Bush.	Ohio. Bush.	Canada West. Bush.
Wheat	18	14	$15\frac{1}{4}$	13
Barley	27	16	24	$17\frac{1}{2}$
Oats	33	26	34	25
Buckwheat	28	14	20	16
Rye	18	$9\frac{1}{2}$	16	$11\frac{1}{2}$
Indian corn . . .	$36\frac{1}{2}$	25	41	—
Potatoes	204	90	69	84
Turnips	390	88	—	—*

This table places the agricultural capability of New Brunswick in a very favourable light, and shows that, notwithstanding its severe winters, the soil of this province, if properly farmed, may favourably compete with the most productive States and Provinces of North America. And although the actual averages for the whole of the cultivated land in New Brunswick do not directly exhibit the amount of produce yielded by the more favoured portions of the province in which the red sands, marls, and limestones described in this paper exist, yet they do in reality prove these districts to be highly productive, inasmuch as the comparatively high averages for the whole colony arise from the admixture of the higher numbers representing *their* yield, with the lower numbers representing the general yield of the soils of the widely-extended coal measures.

IV. *Influence of Circumstances in Modifying the immediate Relations of the Soils to the rocky Formations of a Country.*—The illustrations I have presented in this and a former paper leave no room for doubt that in many cases the agricultural value of the soil over very large areas is directly determined by the nature of the rocks below, and sometimes by the mere geological epoch to which these rocks belong. It is so with the coal measures of New Brunswick, and with the other rocks I have described.

But I have shown also that the physical geography of this coal region—its extreme flatness especially—and the impervious character of its thin-bedded strata, have materially modified, in many places, the natural quality of the surface in respect to agricultural value. Bogs, swamps, and carriboo plains, through these agencies, are made to cover large areas, and thus to give an economical character to the surface, which is altogether independent of the chemical composition which distinguishes the rocks beneath. As the time appears now to have arrived when the influence of circumstances in producing such modifications in the agricultural indications of general geology ought to obtain a more prominent place in our systematic works, I take this opportunity of illustrating the general effect of such influences

* See the author's 'Notes on North America,' ii. p. 193.

upon the agricultural value of the soils which rest upon the coal-field of New Brunswick.

During my stay in that province I was enabled, through the kind co-operation of the Surveyor-general, the Hon. Mr. Brown, and other parties, to publish a map, in which, by different colours, were represented the qualities of the soils over its entire surface. This map included, in addition to the observations made and information collected during my own tour, the greater part of the knowledge which had previously been obtained during the numerous surveys made under the direction of the Surveyor-general and by order of the provincial government. It was, therefore, an exceedingly valuable document, not only in a directly-economical point of view to the practical men of the province—but theoretically also, as affording the means of comparing the actual observed value of the soil in any locality with the indications of its geological structure. From that map I have extracted the accompanying triangular portion, which represents the area of the coal-field, over which, almost everywhere, those grey, generally thin-bedded, sandstones extend, which are exhibited in the geological sections above given (Nos. I. and II.), and which naturally produce the poor soils I have already repeatedly described. On looking at this map, however, it will be seen that various kinds of shading, here substituted for the colours of the original map, are scattered irregularly over its surface. These different shadings indicate to the eye the kinds of soil which are actually found in the several parts of this extensive area. The shading—

No. I. indicates land of the first class, which in its natural state will produce 2½ tons of hay an acre.

No. II. is land of the second quality, which produces 2 tons of hay an acre.

These two are represented by the same shading, as the quantity of each in this part of the province is very small.

No. III. is land which produces 1½ tons of hay.

No. IV. produces 1 ton of hay per acre.

No. V., though covered for the most part with narrow-leaved timber, is considered in its present condition to be incapable of profitable cultivation; and the shading

No. VI. indicates the sites of known bogs, swamps, &c., which in various places rest upon this incapable surface.

Now, at first sight, it might appear as if there were no accordance whatever between the indications of geology taken alone, and the actual observed qualities of the soil, as represented

in this map. A little examination, however, removes this impression, while, at the same time, it shows how other causes operate in modifying purely geological influences, what these causes are, and to what extent they operate. Thus it will be seen—

1st. That only in a few places of limited extent do soils of the first or second quality occur ;—therefore it is generally true of the whole area, that the rocks of the coal measures produce or are covered by soils of an inferior quality.

2nd. That the poorest or most worthless portions (Nos. V. and VI.) lie towards the sources of the rivers—form the higher table-lands in other words, which the rains of summer and the snows of winter may wash and impoverish, but which, in a state of nature, receive nothing by which their natural quality can be materially improved. The highest parts of these regions rarely rise more than 200 or 300 feet above the sea-level, they may therefore be regarded as representing in their soils a quality something inferior to what the rocks themselves, by their crumbling, would naturally produce. The rains have yearly washed them for an indefinite period of time, and the rivers have carried off their soluble portions and their finer insoluble particles, reducing them thus gradually to the condition in which they now are.

There is, besides, in this country, another cause of impoverishment to which, in a state of nature, the surface is exposed, which is not undeserving of special notice. Forests prevail everywhere over the unreclaimed territory, and these, in the scorching days of the North American summers, are subject to frequent fires. The ash of the burned forests, when it falls and rests where the trees grew, excites and quickens a new vegetation, and hence the easy and luxuriant crops which the settler obtains when he has strewed upon his young clearing the heaps of ashes which the felled timber has yielded. But, if the fires are succeeded by heavy rains, the ashes are swept off from the sloping grounds, and the blackened naked surface is robbed of its most fertilising constituents. Hence where frequent forest burnings have taken place the land becomes notoriously worthless. The wind besides assists the rains, and, on the whole, is probably a still more rapid and widely-acting exhauster of these forest lands. Whenever great fires have occurred in the woods of New Brunswick, and along the shores of the St. Lawrence, they have almost invariably been accompanied by powerful winds. The great fire which, in 1825, desolated the northern part of New Brunswick, along the course of the Miramichi river, was pushed on by an irresistible gale of wind, before which it galloped across the country with a speed which carried it over a

distance of thirty miles in a single hour. Such hurricanes sweep smoke and ash and light twigs, and even burning brands, over land and sea, to unknown distances, and thus effectually rob the soil of those quickening materials which the living trees had probably, for half a century, been extracting from it by their roots. It is easy to see how, in these various ways, the rains and winds of heaven must have gradually rendered poorer the naturally poor uplands of this coal measure district; so that, as I have said, the quality of the soils represented by No. V. must be considerably below that which the soils on the same spots must have possessed when the rocks, from which they are derived, began first to crumble through the agency of natural causes.

3rd. Passing over the soils No. IV. which, if what is above stated be considered probable, may be looked upon as representing in some degree the natural quality of the soils of this region, we may dwell for a little on those richer soils which are indicated by the shading No. III. In regard to these it will be observed that they lie in general along the lines of drainage of the country, and towards the outfalls of the rivers. On the one hand, we find this quality of soil bordering the course of the Washedamoak river, skirting the Grand Lake and its tributaries, and following the line of the St. John river, as it crosses this region. On the other hand, the Miramichi river and its feeders, for a great part of their descent, flow through soils of this quality; and so also towards the sea (*Northumberland Straits*, which separate New Brunswick from Prince Edward's Island) into which many streams, rising in the flats and swamps of the higher country, empty themselves, the same better quality of soil prevails. So that generally, we may say, that towards the outfalls of the rivers in every direction the better soils are to be found,—a circumstance very generally observed still in most of the long-inhabited and long-cultivated countries of Europe. And the explanation of this circumstance is easy:—the same atmospheric agencies which have robbed the higher land have enriched the lower. The ever-flowing and frequently-flooded rivers have brought down and deposited in the line of their descent, the materials of richer soils, and have thus gradually—upon rocks of the same geological age and of the same chemical composition—established diversities of soil, which a knowledge of the geological structure alone would not lead us to anticipate, and for which, in fact, this knowledge does not enable us to account. That here and there such richer soils occur in places which existing rivers appear unable to reach, only reminds us how imperfect our information still is in regard to the actual condition of this new country, and to the modifying causes now in operation in different localities; and how still more imperfect is our acquaintance with the earlier

history of the surface of New Brunswick, with the changes which the river-courses have undergone, with the cause of the great deepening which their channels have suffered, and with the numerous other physical alterations by which the influence of the streams upon the country through which they pass must have been very much modified.

It is the character of running streams, when they lose themselves in seas or lakes, or other large bodies of comparatively still water, to let go and deposit near their mouths the solid matters they were able, while in motion, to keep in suspension and bear along with them. Now along the shores of Northumberland Strait there are many indications of a later lifting up of the province, by which a fringe in some places of twenty or thirty miles in breadth, previously under water, was laid dry. While under water, the numerous rivers which cross this coast-line would meet the sea at an earlier part of their course, and all the mud they brought down would be distributed along the sea-bottom, and deposited by tides and currents, probably at considerable distances from their actual mouths, so as to form wide patches of more capable soil, as the shading (No. III.) along this coast-line actually represents. The numerous terraces, rising one above another, along the banks of the St. John river, are unmistakable evidence of the anciently higher levels at which its waters ran. When this was the case, the surfaces numbered I., II., and III., may have been subject to overflow, while the waters of the Grand Lake and of the Washedamoak river may, in like manner, have covered a large portion of the better land by which they are now fringed round or accompanied. Thus, by the aid of ancient changes of level, we may be enabled to explain, in other cases as well as in the present, how existing causes may have given rise to anomalous appearances, which the operation of these causes, in present physical conditions, are insufficient thoroughly to explain.

4th. The soils Nos. I. and II., though very limited in extent, point out another agency, in addition to those already noticed, by which the agricultural indications of geological structure may be, and no doubt are, in many cases, materially modified. In the map before us, there are two spots upon which these soils occupy a considerable area. The first is on the river St. John, below Fredericton; the second at the head of Cumberland Basin, one of the upper branches of the Bay of Fundy. The existence of soils so rich in the first of these localities is explained by the circumstance that, before entering the carboniferous region, the river St. John, or its tributaries, had passed through geological formations of red marls, red sandstones, and Silurian slates, which naturally form very fertile soils, and thence had brought

with them materials of productiveness which were foreign to this region. These were naturally deposited where the river first widened into a shallow lake, and gave birth to the fertile alluvium of which the first and second class soils on the St. John river in a great measure consist. In the second locality, on the head waters of the Bay of Fundy, the lofty tides of that Bay, thick with red mud—the spoils of the soft rocks which they wear down in their daily ebb and flow—have, like the waters of the St. John, brought upwards the materials of other formations, and have overlaid with most fertile soil the more barren surface natural to the rocks on which they rest. It is a natural warping with foreign materials—similar to that performed by our own Humber and Trent on the adjoining moor-lands, or by the river Ombrone upon the Tuscan Maremma—that the existence of these first-class soils in this portion of New Brunswick, are for the most part to be ascribed.

It is unnecessary, I think, to follow this subject at present into further detail; I shall therefore briefly sum up the results to which the study of this case has led us in regard to the relations of Geology with Agriculture, and to the causes by which these relations, naturally close, may be materially modified. These results are—

1st. That the actual agricultural value of the soil in a district may differ very much from that which pure geology alone would indicate. This is shown by the map before us, in which, although the soils special to the formation do predominate, yet soils of all qualities are seen extending often over very large areas.

2nd. That the physical structure of a country has much influence in causing the production of such diversities of soil upon, or from, the debris of rocks of the same age and kind.

3rd. That the existence of flat table-lands, for example, or of depressions having no natural outlet, will cover extensive portions of such a surface with swamps and bogs, in climates which favour the accumulation of vegetable matter. Thus, as in Ireland not less extensively than in New Brunswick, the economico-agricultural influence of geological structure may be disguised or wholly hidden by the purely superficial covering of decaying vegetable matter.

4th. That, generally speaking, the soil of a district of uniform geological character will improve in the direction of the natural drainage and river outfalls. Where rains fall or snows melt, it is the tendency of the flowing water to enrich the lower at the expense of the higher country, and thus to establish differences of soil which did not originally exist. At the same time the final result of such action will depend very much upon the nature

of the rocks themselves. If they consist of limestone, the rains may wash down the finer particles from many places; but wherever soil remains it will still retain nearly the same composition as at first, and will be little impaired in fertility by the action of the rains. Hence the fine sweet herbage which clothes our limestone-hills, and makes them so grateful to the pasturing flocks. Or if hills or table-lands of red marl* form the higher country, portions may be washed down without materially affecting the quality of what remains. Let a fresh portion of the rock crumble, and things are again as they were before. A new soil is produced, equally fertile with that which has been washed away, and thus the fertility natural to the rock will be permanently maintained.

It is different, however, in the case of sandstone rocks, such as those of the coal-fields of New Brunswick. When such rocks crumble they form soils more or less sandy, according to the proportion of fine clay which has been originally contained in the materials from which the rock was formed. Now, the action of heavy rains upon such a soil is not to carry it away bodily, as in the case of the limestone or of the fine red marl, but to wash out the fine clayey particles, and carry them down to lower levels. Thus on the uplands the sandy soils become every day more sandy and of less value, while, in the direction of the drainage, they become, on the other hand, constantly more tenacious and productive.

Thus the amount of influence exercised by physical drainage is itself limited, and determined by the chemical composition of the rocks of which the country consists.

5th. That the passage of rivers or of sea-arms across a poor country, after it has previously traversed a richer geological region, is sure, to a greater or less extent, to modify—to increase, in fact, the value of the surface in the line of its course. This is seen, as I have pointed out, on the St. John river, and at the head of the Bay of Fundy, and is confirmed by observations made by myself and others in nearly all parts of the world.

6th. That partial elevations of the land at successive periods will aid other physical causes in establishing such differences, often, as in New Brunswick, covering with more fertile land the surface which has been most recently raised from beneath the waters of seas or lakes. It is conceivable, however, that in other conditions the very converse may take place.

These practical results are drawn directly from the map before us. Of course they do not indicate or exhaust all the causes by which modifications are introduced into the agricultural indications of

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* Such as is represented in our sections by (3).

pure geology. A similar analysis of other examples will indicate other causes of similar change; and I think these causes ought now, in reference to the specialities of each country, to be made the subject of critical study and examination. The problem in each case to be solved is this. Given a certain geological structure, which indicates generally, and generally produces, certain agricultural capabilities; to what extent and in what localities have these indications been interfered with and modified by other agencies? In what way and to what extent have climate, physical structure, recent changes of physical structure, the neighbourhood of unlike geological formations, the action of those influences which produce what geologists call changed or metamorphic rocks, or other natural causes, been instrumental in producing such modifications? This, like all other more advanced inquiries, is more complicated and difficult than the simple problem of the direct relation between the character and age of a rock, and the quality of the soil it produces when broken up. But it will result in furnishing us with special surface maps, which will be of direct and immediate use to the practical agriculture of every country. And, what will be not less interesting, theoretically, it will at once connect these soil-maps with our strictly-geological ones, through the intermediate agency of physical causes, similar to those which have operated in a greater or less degree at all geological epochs.

II.—*Experiments with Nitrate of Soda, Guano, &c.* By Lieut.-Col. Sir J. M. Tylden.

To Mr. Pusey.

Sir,—I was so much struck with the importance of the experiment detailed by you in the twenty-seventh Number of the Royal Agricultural Journal for 1851, that I determined on trying the nitrate of soda in the continuation of some experiments I had been carrying on for the last three years with soot and guano, and latterly gypsum; and now, having read the paper from Mr. Keary on the same subject, and your own article in the last Number, on the Nitrate Beds of Peru, I take the liberty of sending you the result of my experiments, as any trifling addition to our knowledge of this most valuable manure may be of service in recommending it to agriculturists; and also in confirmation of Mr. Keary's experiments, which so fully bear out the practical view you take of the great value nitrate of soda must become to all engaged in agriculture.

In November, 1851, I set apart five half-acres of wheat; the previous crop had been beans manured with 5 cwt. of rape-cake per acre. The soil is a stiff gravelly, or rather flinty, clay, good wheat land where well used, and, though the dung-cart had not visited the field for six years, it was kept in good heart by alternate cropping and the use of guano and superphosphate of lime, or fish.

No. 1—Had no manure.

No. 2—½ cwt. of nitrate of soda, ½ cwt. of common salt, } Top dressed in February, 1852.

No. 3—1 cwt. of guano at seed-time, harrowed in with the seed.
1½ bushels of gypsum, top dressed in February.

No. 4—1 cwt. of guano, at seed-time.
10 bushels of soot, top dressed in February.

No. 5—1 cwt. of guano, at seed-time.
10 bushels of soot, 1 bushel of gypsum, } Top dressed in February.

The following Table shows the result at harvest-time; but, in consequence of the wet and showery weather, I was not able to thresh the wheat in the field, and had to take it into the barn: the results, therefore, of all the experiments are not so great as they otherwise would have been :—

No. of Experiment.	Manure Used.	Cost per ½ Acre.		Yield of Corn per Half Acre.		Increase over No. 1.		Weight of Straw per ½ Acre in lbs.	Increase of Straw in lbs.	Weight of Wheat per Bushel.
		s.	d.	bush.	gal.	bush.	gal.			lbs.
1	Without any . .	..		17	4	..		1796	..	56½
2	½ cwt. of nitrate . . ½ cwt. of common salt	9	6	22	2	4	6	2096	300	57
3	1 cwt. of guano . . 1½ bushels of gypsum	11	1½	22	2	4	6	2022	226	57½
4	1 cwt. of guano . . 10 bushels of soot .	15	0	21	6	4	2	2392	596	59
5	1 cwt. of guano . . 10 bushels of soot . 1 bushel of gypsum .	15	9	22	4	5	0	2465	669	59

I was induced to try the gypsum, because, having been in the habit of using 2 bushels of gypsum with 2 cwt. of guano, as a dressing for wheat where clover was sown, I fancied that the wheat benefited more where the gypsum was used than without it. These experiments prove I was right. Soot and guano I have used for some time, and always with the most paying success, having in the harvest of 1851 increased my wheat crop by 11 bushels an acre, at the cost of 30*s.*

With regard to the profit of these experiments, I set the wheat at 4*s.* per bushel, and the straw at 6*d.* per truss of 36 lbs.

The profit then of No. 2, with reference to No. 1, after deducting the value of the manure, is as near as possible 145 per cent. upon the outlay:

Of No. 3 exactly 100 per cent.
Of No. 4 about 63 per cent.
Of No. 5 over 80 per cent.

I have induced several of my agricultural friends to try the nitrate this spring, and I have also requested them to use 10 bushels of soot with it, as well as the salt, as the soot not only adds to the weight of the wheat, but increases the straw, and renders it stronger and brighter. I shall hope to be able to report the result of these trials after next harvest. In the meantime, offering you my best thanks for having brought the nitrate to the notice of farmers, I remain yours faithfully,

J. M. Tylden.

Milsted, Sittingbourne, Kent,
February 21, 1853.

III.—*The Farming of Derbyshire.* By John Jephson Rowley.

Prize Report.

It is sometimes said, "good land makes a good farmer;" yet farming is, in many instances, found in a flourishing condition surrounded by great physical difficulties of soil and climate, and making but a limited return for the labour bestowed upon it. The soil, too, may be rich in all the elements necessary to produce and maintain vegetable life, while the situation is elevated and the climate cold and uncongenial. And such is the county I am going to treat. It contains land of the richest kind, both for arable and grazing purposes. The banks of the Dove, where old Izaac Walton loved to watch the stream, are proverbial for the grazing qualities of its pastures, and the lands washed by the Derwent and the Trent are "flowing with milk and honey." Derbyshire is no less fertile in its arable soils; but at the same time it possesses in abundance the wild and desolate moor and the mountain waste. Its climate is no less variable than its soils. Near the centre of the county rises the first link in the great Alpine chain of England which, intersecting the county, continues onward to Scotland. Parallel with its mountains lies embedded its vast and valuable coal-field, ex-

tending (according to Farey's Report) over an area of 130,000 acres, the greater part of which abounds in iron.*

The accompanying map of the county, with its geology, will sufficiently show its boundaries without attempting further to describe them; nor will it be necessary in an Agricultural Report to notice its hundreds or parishes. The population of the county in 1841 was 272,217 persons, and in 1851, 296,084. In the county-town there were 32,741 inhabitants in 1841, and in 1851, 40,609, showing a progressive increase.

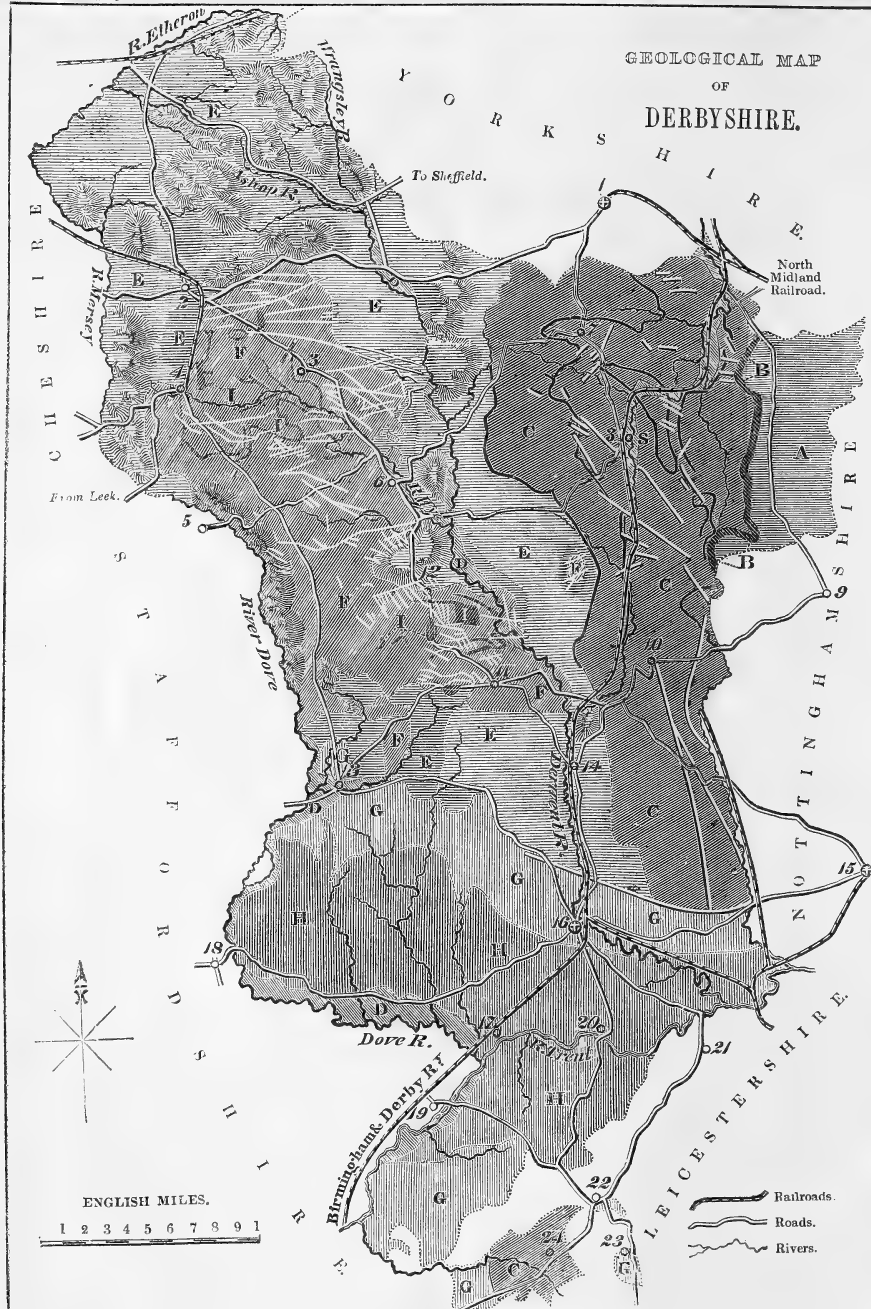
Before describing the farming of Derbyshire, it may be well to glance at the geological aspects and arrangements of the different strata, as on these mainly depend the nature of the soils and subsoils, upon which, *in the first instance*, successful farming must depend; and no county in England presents a greater variety of geological character. To commence the tour of the county, and starting from its southern edge, near to Weston, or Cavendish-bridge, the beautiful valley of the Trent spreads itself on the east and west, as far as the eye can reach. Travelling northwardly from this rich and fertile plain to Derby and the Derwent, and about two miles beyond, the highest basset or outcrop of the new red sandstone shows itself, overlooking another valley no less beautiful, if less extensive than the Trent. The millstone grit makes its first appearance in this locality, and in the distance may be seen the first glimpse of the carboniferous limestone in that wonderful outburst of Crich Cliff, towering 1000 feet above the sea, and starting up from the midst of the millstone grit. Continuing onwards, up the Derwent valley, through the rocky pass of Millford, then to Belper, Ambergate, and Cromford, and Matlock Bath, a different series of rocks occur. And here commences the first of those rocky dales in the mountain limestone that characterise the Peak of Derbyshire, and have rendered it an object of such attraction and interest for its romantic beauties. Passing on by Darley Dale, Rowsley, Haddon, Bakewell, and Ashford, the traveller to Buxton gets glimpses on every side of numerous dells and dales, and meets with extensive views from the top of Taddington Hill, from which he descends by the Wye to Buxton. In doing

* Farey's Report gives the area of the county as 622,080 acres, and divides it into the different strata as follows:—

	Acres.
Clays and marls of South Derbyshire	158,000
Yellow lime (magnesian)	21,580
Millstone-grit shales (with the lower coal)	220,500
Mountain limestone with toad-stone	92,000
Coal measures	130,000
Total acres in Derbyshire	622,080

Later-published estimates make the county 663,180 acres.

To face page 19.



ARRANGEMENT OF THE STRATA.

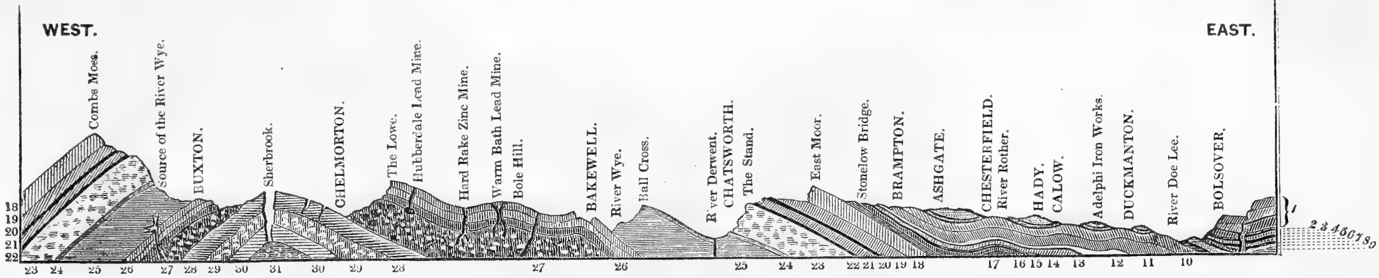
Magnesian Limestone ..	A.
Lower New Red	B
Coal Measures.........	C
Alluvium	D
Millstone Grit and Limestone Shales........	E
Carboniferous Limestone	F
New Red Sandstone	G
New Red Marl.	H
Toadstone....	I
Mineral Veins...,......	
Outcrop of Coal Seams.	
White Lines—Faults.	

REFERENCES TO THE TOWNS.

1. Sheffield.
2. Chapel-en-le-Frith.
3. Tideswell.
4. Buxton.
5. Longnor.
6. Bakewell.
7. Dronfield.
8. Chesterfield.
9. Mansfield.
10. Alfreton.
11. Wirksworth.
12. Winsten.
13. Ashborne.
14. Belper.
15. Nottingham.
16. Derby.
17. Willington.
18. Uttoxeter.
19. Burton-upon-Trent.
20. Swarkeston.
21. Castle Donnington.
22. Ashby-de-la-Zouch.
23. Ravenstone.
24. Measham.

SECTION OF THE STRATA IN DERBYSHIRE FROM EAST TO WEST.—By White Watson, F.L.S.

Scale, 6 Miles to an Inch.



REFERENCE

1. Crystallized Granular Limestone.
2. Grit.
3. Rock-Coal.
4. Grit, Shale, Ironstone, and Clay.
5. Rock-Coal.
6. Shale, Ironstone, Clay, and Grit.
7. Rock-Coal.
8. Grit.
9. Grit.
10. Ferruginous Grit.
11. Whetstone Grit.
12. Grit.
13. Cankstone.
14. Rock-Coal.
15. Organic Grit.
16. Friable Grit.
17. Bituminous Shale.
18. Grindstone-Sandstone.
19. Fatiscent Grit.
20. Rock-Coal.
21. Clay Coal Bind.
22. Rock-Coal.
23. Millstone-Sandstone.
24. Argillaceous or Shale Grit.
25. Aluminous Shale, or Slate.
26. Compact Shell Limestone.
27. Spheroidal Basalt, with Basaltic Amygdaloid.
28. Compact Scaly Limestone.
29. Basalt and Basaltic Amygdaloid.
30. Compact Sugar Limestone.
31. Basalt and Basaltic Amygdaloid.

this a great breadth of the barren tracks of the Peak will have been passed over, which has made farming in the North a different trade from what farming is in the South, not so much from its altitude as from the steep, rugged, and nearly soilless sides and crags of the limestone, and the equally steep and rugged ascents of the millstone grit, and from its bogs and moorlands covered with heath and boulder stones of every size. The road from Matlock to Wirksworth leads through a district of mineral wealth, where mining, and not farming, is the great staple. The matrix of lead ore is the mountain-lime, known to the Romans of old as well as the Saxons, and now more successfully worked by their descendants with improved means and machinery. Not the least of the difficulties of the ancient lead miners would be the bad state of the roads, and absence of means of transport except that which was tedious and difficult. These difficulties have been removed by improved roads in the first instance, and by the opening of the Cromford Canal and High Peak Railway early in the commencement of the present century. But before this, towards the close of the last century, a new element was introduced amongst the wilds of the Peak, which exerted a mighty influence on the character of North Derbyshire: Arkwright had realized his great invention, and introduced the cotton-trade. Taking advantage of its streams and waterfalls, cotton-mills began to occupy the most sequestered places, and the Wye and Derwent put thousands of spindles in motion. These factories brought a population: wealth increased, both agricultural and manufacturing, and gave a stimulant to improvements of every kind. Progress became the rule, more especially in those parts within reach of these influences: agriculture and manufactures joined hands.

The foregoing remarks refer chiefly to the northern division. I must now travel south, and briefly point out some of the geological features in that favoured region. Beginning at Ashbourne, and tracing a line by Mugginton, Kedleston, Allestree, Dale Abbey, to Sandiacre, the northern boundary of the red marl or new red sandstone will be pretty accurately pointed out. Thence this extensive formation continues to the counties of Nottingham, Leicester, and Stafford, presenting the same or similar features in common. In South Derbyshire it consists of what geologists term saliferous and gypseous shales and sandstones; conglomerates and clays. These clays and sandstones are sometimes interstratified, or alternate with each other, and form beds of immense thickness, as the gypsum or alabaster pits, so extensively used for plaster and ornaments. These measures, wherever they appear, produce the finest arable land, especially where the soil consists of a fair portion of calca-

reous matter (lime) blending the argillaceous or clayey, with silicious or sandy matter. This forms a light soil; but where the argillaceous or clay prevails, then a heavy and cold soil will be the consequence. This measure, occupying all the southern parts of Derbyshire, contains the saliferous salts of soda, potash, and lime; hence its fruitfulness when the culture is properly attended to.

With this short sketch of the geology of Derbyshire, I shall endeavour to notice, as I proceed, the peculiar and distinctive features of the five different soils into which I have divided the county, with a view to treat of each. These divisions of soil will be taken in the following order; viz.—

1st. The Magnesian Lime;
2nd. The Coal Series;
3rd. The Millstone Grit with the Shales;
4th. The Mountain Lime;
5th. The Clays and Gravels of South Derbyshire.

The soil of the magnesian lime is generally chocolate-brown; the subsoil is poor, containing 44 per cent. of carbonate of magnesia. The stone is superior as building stone, that at Bolsover Moor taking a polish nearly equal to marble.

1st. *The Magnesian Limestone* occupies a small section on the eastern side of the county, and is comparatively trifling in extent. According to former estimates it contains 21,600 acres, and is about 10 miles long by 3 to 5 wide. The soil is of an open and friable nature—useful, but not rich—yet capable of being applied to all the purposes of modern husbandry. The magnesian limestone commences with the coal measures near Nottingham, and runs parallel with the Derbyshire and Yorkshire coal-field, where the coal ceases, the limestone continuing on to Durham. In Farey's Report of the Minerals and Agriculture of Derbyshire (1817) very little is said of the magnesian limestone. "The soil," he says, "is of medium quality and degree of tenacity; it is much improved by Peak-lime where the canals admit of its application, or by lime from the blue beds at the bottom of the series. It seems best adapted for arable land, on account of its proneness to shar-grass—dry grass which scarcely any thing will eat." Since the time Farey wrote his Report some improvement has been made on this soil, not only as regards the mode of husbandry, but in the *non-application of quick-lime*, and the substitution of other and more valuable manures. It is what may be aptly called a "turnip and barley soil;" and to the extended growth of turnips and sheep-farming may be attributed its vast improvement in modern husbandry. Mr. Siddons, of Pleasley, was the first to introduce

the drill system, and an extended growth of turnips on the ridge as then practised in Northumberland, as well as the use of bones as manure, about the year 1800. Although the bones were round and broken only by the hammer, the advantage of using them soon became apparent; and the writer's father was the first to follow the example. Their use soon became general on the limestone; and guano, or any other kind of artificial manure, has not removed them from their high position.

The subjoined analysis of the soil and rock of the magnesian lime has been made by Mr. James Haywood, Professional Chemist, Sheffield, and shows a great deficiency of phosphates; hence the application of bones is attended with such favourable results.

Analysis of magnesian limestone soil: 100 parts contain—

Organic matter, principally humus, with roots and fibres in a state of decay	10·200
Water	3·800
Silicates containing ·590 of potash and ·378 of soda	69·718
Alumina, oxide of iron, and manganese	6·902
Carbonate of lime	4·120
Carbonate of magnesia	4·230
Phosphoric acid (combined)	·008
Sulphuric acid ditto	·002
Chlorine ditto	·006
Soluble potash and soda	·004
Soluble silica	·003
Loss	·007
	100·000

Analysis of magnesian limestone substratum taken from the same field as the above soil: 100 parts contain—

Carbonate of lime	52·80
Carbonate of magnesia	44·00
Silicate of alumina, containing potash and soda	1·84
Alumina, oxide of iron, and manganese	6·70
Phosphate of lime	·25
Loss	·41
	100·00

The county boundary which separates Derbyshire from Nottinghamshire on the east intersects the edge of the magnesian limestone near Hardwick Hall, which stands—with the villages of Rowthorne, Glapwell, Palterton, Bolsover, Oscroft, and Barlborough—on a high and level ridge 600 feet above the sea, and overlooks the coal series. The surface then becomes slightly undulating, and the soil, varying in depth, occasionally presents a crag to the ploughshare. The Acts of Parliament for the enclosure of the waste lands were obtained in the early part of last century, and Elmton Common only remained to be enclosed in

the year 1849. The farms vary in size from 50 to 300 acres, and are generally well cultivated, presenting a garden appearance.

The general uniformity of its soils gives an uniformity in the course of cropping throughout, and may be placed as a 5-years' course: but it is subject to change to suit the farmer's convenience. These changes are not considered as objectionable: they are a part of the alternate system, and are useful in the general plan; and are as follows:—

1st Year.	Turnips on fallow.	1st Year.	Turnips on fallow.
2nd ,,	Barley, seeded.	2nd ,,	Barley, seeded.
3rd ,,	Mixed clovers with common or Italian rye-grass, mown.	3rd ,,	Mixed clovers, with rib-grass, rye-grass, or Italian.
4th ,,	Seeds, pasture.	4th ,,	Seeds, pasture.
5th ,,	Wheat.	5th ,,	Rape.
6th ,,	Fallow.	6th ,,	Wheat.
		7th ,,	Barley or oats.
			Fallow.

One of these plans gives a 7-years' course, and reduces the tendency to clover-sickness, so much complained of. The difficulties and the frequent losses attending the growth of clovers have of late years been so serious that many occupiers have abandoned their use, and for one course sown Italian rye-grass instead, in the hope that the next course would be more favourable to the red clover. The introduction of rape after ley has been lately introduced as a preparation for wheat, and will, without any doubt, be continued. The second year's ley is winter-ploughed, and crossed in the spring, dressed down, and rape-seed, at the rate of 3 lbs. to the acre, sown broadcast; but no manure or tillage given, the land being in good condition. The rape consumed on the ground with sheep has a tendency to keep it so. Excellent crops of wheat have been obtained in this way, and noble crops of barley have followed. Sometimes the wheat stubble is fallowed for turnips, on the principle that two white crops should not be taken without a green one intervening. The land is, however, after rape and oil-cake consumed on it, in a fit state to grow a second white crop after the wheat.

Preparing Turnip Fallow.—The plan of autumn-dressing the land in preparation for the turnip fallow has become general. Every effort is made to accomplish this; and the letter of Mr. Pusey, in the Society's Journal, directing the farmer's attention to its advantages, has given additional force to the plan. The land is well scuffled on the surface, harrowed, and cleaned—the weeds removed and burnt, or, if not numerous, they are ploughed down by a deep furrow during the winter. Some farmers have lately, to save time at a busier period of the year, given the fallow 6 or 7 loads of manure previous to the winter ploughing. It then receives another ploughing and dressing in the spring,

the manure being well incorporated. It is then in a fit state to be sown with Swede turnips in May, or common turnips in June. The sowing of turnips is continued to the first week in July, and considered in good season, when they are required for use in the following spring. Bones, guano, and rape-dust are the tillages usually purchased for the turnip crop, but the quantity applied is not so large as formerly. Two quarters of bone-dust and 4 cwt. of rape-dust, with turf or soil ashes, is a common dressing. To this is frequently added 1½ or 2 cwts. of guano per acre, sown broadcast; but the guano is seldom applied when farm-yard manure is used. This application is liberal, and will cost nearly 4*l.* per acre; but it carries the land through the course. Excellent turnips are obtained at less cost; and frequently, for a change (and with a view to suspend the use of bones, &c. for one fallow), farm-yard manure only is applied. Swedes are drilled on the ridge from 24 to 28 inches wide, and occasionally the common and hybrid kinds are ridged, but more frequently drilled flat, from 14 to 20 inches. Hand and horse hoeing follow in proper course: turnips intended for early use are made thinner in the rows, and those to remain in the ground through the winter are left thicker, smaller turnips being preferred in the spring for ewes and lambs. While making these remarks on the turnip fallow and the manures applied, it may not be out of place to notice a novel mode of preparing farm-yard manure for the turnip crop. The plan is a part of the box-feeding system, but with this difference—the manure is made under a large shed, spouted, with a small yard attached, capable of holding 15 or 20 calves during the winter. Into this shed nothing but what is very short is allowed to go—such as sawdust, shoddy, bones, soot, chopped straw, &c., and all the manures obtainable without straw, as cow and horse dung. In this way, layer after layer, a considerable quantity of rich manure is made, and, having received no moisture but urine, is soon prepared by turning and mixing for the drill. Previous to turning, the heap receives a small quantity of diluted sulphuric acid and salt. The bones are usually bought and laid in the yard before Christmas, and in the spring are in a state of decomposition. Farm-yard manure, well incorporated with valuable tillages, is in this state applied by drill to the turnip crop at the rate of 60 or 80 bushels per acre. With all these different tillages, but none in excess, excellent crops of turnips are obtained. This system of preparing manure is practised by the writer, who believes that, as surely as guano owes its rich and fertilising properties to the absence of rain, so surely should farm-yard manure be made and treated, and, like guano, have no rain-water washing away its most valuable properties. This system is

opposed to the tank, and the distribution of liquid manure either by pipes or water-carts; and, in the writer's opinion, will outlive it. On the magnesian limestone very few tanks can be found. "They don't answer," it is said—"they are too much trouble." Another says, "I have spouted my buildings, and converted my tank into a soft-water cistern; and I would advise everybody else to do the same."

Management of Crops.—After three-fourths or four-fifths of the turnips are consumed on the ground with sheep, the next operation is drilling the barley in the spring at the rate of 3 bushels to the acre, which is generally admitted by practical men to be the proper quantity on these soils. Drilling is preferred, because it allows the land to be dressed down and fallowed, to remove any remnant of weeds left from the previous year. The clovers are sown at the same time, and mixed or not with Italian or common rye-grass to suit the farmers' purposes. Some never mix the clovers, but sow clear white after one fallow, and clear red and cow grass after the next; and by this means prevent the frequent repetition of the red clovers. Eight to 12lbs. of clover seeds, and 1 to 2 pecks of rye-grass, are the usual quantities applied per acre. On limestone farms there is usually a want of old grass land, and the clovers are usually mown the first year and pastured the second. After this follows the rape, as before given, or the wheat. The land is ploughed with the skim-coulter and pressed down, and the seed-wheat sown at the rate of 2 bushels per acre. Occasionally, where the width of the fields will admit, the harrows follow the presser, and the wheat is drilled across the ploughing. The advocates of this system state, "the wheat is not so much choked with grass." Ploughing matches, in the autumn, are encouraged by the Heath, Bolsover, Staveley, and other farmers' clubs. A spirit of emulation is with the ploughman; and the land prepared for wheat is as true and straight in the furrows as if geometricians had been at work with parallel rulers.

Lucerne and sainfoin are gone out of fashion: it would be difficult to assign a reason why the latter is not more extensively grown, excepting, perhaps, "the land is wanted for turnips." It is a fact that, since the growth of Swede turnips has been pushed to the present extent, but little sainfoin is grown. The turnip, and all that follows in its train, the barley, the wheat, and the sheep, appear the great staple of magnesian soils.

The Breed of Cattle is of a mixed and various kind. They are chiefly bred on the land, and have been improved by the admixture of Durham blood; but they have been more improved by better nursing and rearing. Some are bought in the autumn for the straw-yard, where they receive during the winter a little oil-

cake with the turnips: they are bought chiefly to make manure, and the farmers want manure at home in a collected state. A great deal of money is expended every year in both rape and linseed cake, which, when ground into powder and mixed, both cattle and sheep eat with avidity. Stirks that are bulled young, and calve at grass in May or June, are usually turned out to pasture to rear their own young.* Sometimes they will rear two calves, and make good nurses to both. Very little cheese is made on these soils, and cows are kept to supply the house and the ploughmen with milk rather than to make produce for the market.

Sheep.—The principal live stock on the magnesian limestone are the sheep, for which the soil is well adapted. The Leicester blood predominates, and splendid specimens of breeding ewes may be found. Mr. John Armstrong, of Palterton, has lately crossed his ewes with the Shropshire Down ram, and obtained more flesh without reducing the weight or quality of the wool. The great end sought to be attained is early maturity, without an accumulation of fat. It is the great complaint against the Leicesters that as the fat increased the muscle disappeared. The same complaint was made against them in Farey's time (1812); and that writer, to compare their merits with the Merinos, says, "Mr. Thomas, of Chesterfield, lately sold some of the latter at four years old, because the annual profit from the wool enabled him to keep them with advantage." Wool was then the paying point. The case is different at the present day: two-shear wethers are the exception; they are rarely found in the markets. The best of the hoggets are sold after clip-day to make room for the growing lambs, and at the time of Michaelmas few are left in the farmers' hands. Another complaint made against the Leicesters is, they are bad nurses; and, like other high-bred animals, refuse milk to their young. For these reasons the pale faces are giving way, and the grey ones taking their places; but it is a question how long the mixed Down and Leicester will continue to supply meat and milk. If the animal continues to be forced and nursed, it may lose in a great degree its hereditary muscle; and if the formation of muscle depends on motion, ard food can be obtained without searching for it, the Down may become as quiet, as good tempered, and as slothful as the Leicester, and give us fat instead of the lean meat so much sought after. Sheep go on to turnips in October, the usual calculation being to provide turnips until the first week in May, when the young clovers are ready. The turnips are cut into mangers; but a few are given on the ground on a Saturday, to ease the labours of the

* When a young cow is suckling two calves, care must be taken that her own calf is not one. It would always be the favourite.

shepherd the following day. A man and boy will attend to 200 sheep, and cut them turnips during the winter. Dry food of some kind is given them, either mixed oil-cake, hay, or barley chaff. One farmer of my acquaintance treats his hoggets with a little bran every day, but he is an extensive miller; another gives them malt-dust (cums), but he is a maltster. When the turnips are finished, ewes and lambs have a plot of cabbages provided until the grasses are more plentiful. An accident last year showed the excellent keeping qualities of the red cabbage, commonly used for pickling. A few scores of these were planted in the ordinary way with the common ox-cabbage, and though they did not get so large they kept better, were sounder, and the ewes gave them the preference. These advantages were seen; and as there are no patents in nature, another year some acres of *pickle cabbages* will be provided for consumption in May, when other roots are exhausted. Wool, like mutton, goes in at the mouth, and is dependent on the health and condition of the animal. Hoggets, at the shearing in May, will give from 7 to 9 lbs. of wool each, and ewes something less. The price received for limestone wool last year, of average quality, was 32*s.* per tod of 28lbs.

Implements.—The implements in daily use are of the ordinary yet improved kinds, from the steam-engine to the harrow. Every village has several fixed and portable thrashing-machines by Hornsby and other makers, and several moveable steam thrashing-machines are continually at work. It is a fact that without machinery corn could not be thrashed; and it is no less a fact that some corn last harvest was thrashed before it was cut, and lost in the field for want of harvesters. Farmers are most anxious for the success of the reaping-machines, and only wait to be fully satisfied they are workable to give orders.* One of these machines, made by Taylor of Edingley, near Mansfield, was tried last year in a field near Palterton, but the trial was a failure. It would mow down the thistles in a grass field, and cut stubbles, but it refused to cut the corn. Much credit it due to Mr. Taylor for having brought out his machine, and reducing the price of it, and it is hoped another year he will be more successful. Ploughs are of wood, and made in the neighbourhood; they have steel boards, and are much alike in merit, no maker having the preference. Drags or scufflers, for stubble-paring in the autumn and dressing the fallows, are in the hands of every farmer. They are very simple yet effective tools, and usually made by the village carpenter. The depth is regulated by wheels, and they are

* It is hoped that another year all draining operations, and all works of improvement, where time is of little consequence, will be suspended during the harvest. It would be advantageous to farmers and labourers and the public at large.

easy to manage. Turnip-drills, corn-drills, and horse-hoes are no less common; they are made at Edingley and Worksop, and one made by Smith, of Peasenhall, is considered the best in the district. The horse-rakes, made by Smith of Stamford, are the most useful implements on a farm: they are not numerous, but they must, now labour is dear, become so. Corn-dressing machines, blowers, and hummellers, are in every barn, and often attached by belt and pulley to the gear of the thrashing-machines. Gardener's turnip-cutter is rarely seen; perhaps it is because a cutter answering the same purpose is made at less cost. It is a complaint frequently made by the farmers, that the cost of implements has not been reduced proportionately with the price of other articles; and many are made, and will be made, on the farms.

Carts and Waggons.—The old-fashioned ponderous carts and waggons are replaced by light and handy machines. Waggons have the preference in the harvest-field, particularly where the land is hilly.

The subsoil-plough is not a common implement on the limestone, the thinness of the soil being unfavourable to its working. Where it can be worked, it is of the greatest advantage in destroying thistles and other deep-rooted weeds.

Before leaving the implements of the limestone soils, it may not be out of place to notice more particularly the moveable steam-thrashing machine of Mr. Scorer, of Scarcliffe. It is the most complete machine of its kind. The thrashing part is made by Goucher, of Woodsetts, near Worksop; the engine, of six-horse power, by Tuxford and Sons. It was a debatable question with Mr. Scorer, whether he should have a fixed or moveable engine. He decided to have the latter, and it may be said that he has both. When the engine is drawn into the shed or house made on purpose, it then becomes a fixture, and works from a belt and pulley-wheel all the barn and farm machinery. It requires no trouble in fixing; the curb-stones and the blocks are so arranged, it cannot be placed wrong. In this way it answers all the purposes of a fixed engine, and it can at any time be moved at pleasure.

2. *The Coal Series* is of great extent, as already given, and presents a different aspect and character to the magnesian lime. It is undulating and rolling, ridge and furrowlike. What mighty power deposited for the use of man its valuable beds of coal and iron, it is is not now my province to inquire. The measures connected with the coal-fields are generally of a perishable and clayey character, and the soils and subsoils over its entire extent partake more or less of a wet, spongy nature, and are cold and sterile unless well drained, and treated with other manures and

soils to give them a more open and friable nature, and furnish those elements that make other soils fruitful. In the cultivation of these soils, the maxim of Arthur Young is in full force and influence:—"*Plough deep to find the gold*," said that distinguished farmer. Never were words spoken more truthful, and conveying more useful information to the cultivator of cold and heavy land. The subjoined analysis of soil from the coal series is by Mr. Haywood, of Sheffield, and taken from a field near Chesterfield:—

100 parts contain, chemical and mechanical analysis—

Stones and gravel not analysed	5·250
Organic matter, consisting principally of humus, with roots and fibres decaying	8·660
Water	7·790
Silicates, containing ·640 of potash and ·280 of soda	70·400
Alumina, oxide of iron, and manganese	6·840
Carbonate of lime and magnesia	·970
Phosphoric acid (combined)	·012
Sulphuric acid ditto	·008
Chlorine ditto	·018
Soluble potash and soda	·037
Soluble silica	·003
Loss	·012
	100·000

Note by Mr. Haywood.—"This soil has most likely been treated with lime and salt recently. The excess of soluble potash is owing to the soil being taken in a very dry state. The proper manures for these soils will be ammonia and phosphates."

The Gritstone soil of the coal series does not differ materially in its chemical composition from the clay; as a general rule, however, it contains less potash and soda, though these valuable ingredients are always furnished by the mica contained in it in sufficient quantity for all ordinary crops. The soil is of an open and friable nature, and well adapted for the growth of root crops, affording an excellent layer for sheep consuming them on the ground. It is of limited area, and mixed in the same district with the clay, and very often in the same field. The course of cropping on these soils is similar to the magnesian limestone, but the turnips are not consumed on the land with the same regularity. The following is a common practice:—

1st Year.	Fallow, turnips and cabbages.
2nd do.	Barley.
3rd do.	Clover seeds, mixed with Italian and common rye grass, mown or pastured.
4th do.	Wheat.
5th do.	Beans, peas, or tares.
6th do.	Oats.
	Fallow.

This appears to be the common practice on the grit soils of the coal series, but it is subject to variations, as more or less sheep are kept on the farm. Generally they are in small numbers, the farmers on these soils trusting more to cattle and dairy purposes, rather than the breeding and fattening of sheep. The great bulk of the turnips are drawn and consumed in the stall by cows, and in many parts of the county excellent cheese and butter are made. On the colder and retentive soils the course of cropping is as follows:—

1st Year.—	Fallow.
2nd do.	Wheat.
3rd do.	Clover, mown.
4th do.	ditto pasture.
5th do.	Wheat or oats.
6th do.	Spring or winter beans.
	Fallow.

It must be observed, in treating of these arable soils, that where the drainage is perfect the fallows are sown with turnips, cabbages, or other root-crops, and the extent of the root-crop is depending on the season and other circumstances. As much land as can be got ready by the end of June, or the first week in July, is sown with turnips, and the remainder is allowed to go on for wheat. Some good pasture and meadow lands are found, and, where drained, are continually improving, and the quantity of sheep are on the increase. I very much regret the continued rains of the winter of 1852-3, and the severe frost which followed, should have prevented me examining with a farmer's eye this interesting district. Beginning near Nottingham, and continuing north, the Erewash Vale is rich in its agriculture, but it is richer far in coal and iron.

The extensive farms of William Jessop, Esq., of Butterley and Codnor Park, are in a high state of cultivation, and "Golden Valley" annually shows to the reaper its golden harvest. Some years ago these farms were more particularly devoted to the breeding of short-horns, and high prices were given to establish a stock. The pets and the forcing system have for some time been abandoned as "flat, stale, and unprofitable," and a more economical and profitable plan adopted. The farms on the Butterley and Codnor estates are thoroughly drained from 3 to 4 feet deep; but it will require many years to complete the drainage immediately surrounding. South of this the drainage is discreditable and the farming neglected; or, it may be, the district looks worse by contrast with the garden-cultivation before alluded to. It must, however, be admitted that something is doing: some draining is going on, and some progress made towards the reclamation of these cold and impracticable clays.

The price paid for draining—including cutting 3 feet deep, tiling, and finishing—is 2*s.* 6*d.* per acre of 28 yards, and varies only when occasional stones are found. In this locality there is a difference of opinion prevailing as to the advantage of placing gravel or coal-slack over the tile; the occupier of one farm contending that "it is of no use draining without gravel," while another contends "that it is unnecessary," that "if the tile is properly placed at the bottom of the drain, the water *can't* be kept out of it." Perhaps an examination of the subsoil would solve the difference of opinion, and show a greater percentage of sand in one than the other. In the parish of Alfreton lime has been extensively used on the wheat fallow for years; "it is now less thought about"—"the land has had enough," and rape-dust, at the rate of 4 to 5 cwt. per acre, is taking its place, and saving the great wear and tear in the cartage of this heavy material, and reducing the cost of growing wheat. The rape-dust is drilled with the seed on a stale furrow, and noble crops of wheat follow; but no figures are produced in the experiment to show the advantage of such application. The noble crop of wheat may be owing to other causes—*to the thoroughly-drained land*, to a clean summer fallow, and last—but not least—to the wheat being drilled on a stale and solid furrow. It is to be regretted that farmers generally do not apply the pounds, shillings, and pence calculation to their trials and experiments, but satisfy themselves with the eye, and are content without pocket proof.

On the farm of James Oakes, Esq., Riddings House, winter beans were tried for the first time last year (1851-2), but the crop was considered a failure. At the present time they are looking very well, drilled on a clover-ley, after which, with an autumn dressing and a little manure, a good crop of wheat is expected. The growth of winter-tares, mixed with rye and wheat for summer folding, is extending, and in a few instances the crop has been consumed on the ground with sheep, and the following wheat-crops have yielded what is considered the fair average on these soils of 4 quarters to the acre. In this case the ploughs follow the sheep, and the land receives a slight dressing of manure the last furrow; the wheat is then drilled at the rate of 2 bushels to the acre. The great staple of the district is wheat, and many acres at the present time (February, 1853) are left unsown, and must stand over for Lent corn. On the farmstead there is a novelty in the construction of stalls, intended for the use of either cows or horses, which is worth notice. The stalls are 8 feet wide, and in the centre rises an iron horse-manger and rack, such as are in common use, and on each side the horse-manger are troughs for the cows. The stalls have no

pretensions to anything but utility, are comfortable as a feeding-house for cows, and are good stables when required.

The greater part of the land in this part of the county is in small estates of freehold. Improvements, if not rapid, are going on. Tileries are common, and pioneer the way to extensive drainage. Farmsteads are defective, and require restoration and enlargement. The farms are of small size, and from 50 to 150 acres in extent.

Few places in the county are marked with greater improvement than Morton, near Alfreton; the soil is on the coal-measures, and varied; occasionally dry, but most generally requires drainage. The subsoil is open and porous near the village, but the greater part of the parish is a cold, flat, and retentive clay; it owes its improvement to the enterprise of two medical gentlemen having capital, and skill to use it in well-directed labour. Ten years ago Morton was proverbially a cold and neglected morass: its dykes and hedges wild, its drainage neglected, and its harvests later than any place in the locality. It is now changed, and one section of the parish an oasis, compared to the watery waste around it. Sheep are kept sound where none could live before, and early lambs, sporting in the snow, are browsing on Italian rye-grass equal to any in the county. The principal agent in this improvement is drainage. Dr. Cooper succeeded to a poor and cold, exhausted farm, and immediately commenced operations by calling in the aid of Mr. Wm. Tebbutt, a draining surveyor of eminence, to devise plans for the complete and thorough drainage of the farm. The work commenced at a uniform depth of 2 feet; and Dr. Oldham quickly followed the example: the latter, however, had some misgivings, and, having read a paper on under-draining in the Society's Journal, changed his plans. The drainage, then, on one farm was cut 4 feet deep, 16 yards apart; the other remained at 2 feet, 8 yards apart. In both cases the 2½-inch pipe was used, and the material returned into the drain. Presently it was discovered that both drainages were imperfect—both wrong: the one erred in width, the other in depth; 2-feet drains were too shallow, and the 4-feet drains were put in at too great a distance. After some experience in draining, these two gentlemen came to the decision "*that a drain 3 feet deep, and 8 or 9 yards apart, was the best and cheapest mode of draining cold clay lands;* and this is now their practice *and the general practice of the neighbourhood.* The fallows are subsoiled at the winter-ploughing as deep as the strength of the team will allow; sometimes with 2 horses only, by an implement of much easier draught than Reid's, at one-third the cost. As these *medical* farms are pointed out as models of agricultural excellence, it may be well to give the course of cropping followed on each :—

Dr. Cooper's course.

1st Year.		Fallow, turnips, cabbage, or kale.
2nd	,,	Wheat or barley.
3rd	,,	Winter beans.
4th	,,	Wheat.
5th	,,	Fallow for roots as before.
6th	,,	Barley or oats.
7th	,,	Seeds, mixed clovers, and Italian, mown.
8th	,,	Pasture.
9th	,,	Wheat.

Dr. Oldham's course.

1st Year.		Fallow, turnips, mangold, and cabbage.
2nd	,,	Wheat or oats.
3rd	,,	Clover seeds mixed, pastured with a small portion of Italian grass.
4th	,,	Wheat.
5th	,,	Winter beans, peas, or tares.
6th	,,	Wheat or oats.
7th	,,	Fallow, turnips, cabbages, roots, &c.
8th	,,	Oats or wheat.
9th	,,	Seeds, a full crop of Italian rye grass for mowing, 1 bushel sown to the acre.

In these courses two white crops in succession are avoided—the legumes and roots come between; turnips are grown with superphosphate and farm-yard manure, and the straw is consumed by feeding-cows eating cake and turnips. The estate of Morton is the property of —— Sitwell, Esq., of Stainsby, and under the agency of Mr. Chambers. The farms are small, being generally less than 150 acres. The general management is improved, root-crops have increased, the climate is improved by drainage, and the snipe driven away to find a home and soil more genial to its nature. But this is not all done at Morton. What has been done can be done again. The political economist who accused the proprietors of Derbyshire of neglect and indifference to agricultural progress might at one time have cited Morton to prove the charge; or, if he travelled by rail, he might, after crossing the Amber, and journeying towards Chesterfield, find abundant evidence to substantiate the unenviable reputation.

The Hardwick estates of the Duke of Devonshire are chiefly on the coal series. The soil is variable and mixed: in the same field may be found wet and dry patches, but the greater part is a heavy and tenacious clay. The improvements in progress are very extensive, both in draining and building. A staff of builders and drainers are continually employed in reclaiming the clays and restoring the decay of many years; the farmsteads are improved; and, to do the noble owner and his excellent agent justice, what is done is well and substantially done. If there be any advantage in the delay of bygone years, it is that these important works remained in abeyance to a period of time when they are better understood. The drainage is the most important feature. Since the establishment of the Staveley Tile-Yard, in 1837, there has been manufactured to the present time —including the yards at Oscroft, Holmwood, and Harstoft— 8,000,879 drain-tiles and pipes. Taking 2000 tiles as the average quantity to drain an acre of land, 4000 acres have been

well and thoroughly drained that will be of lasting service for future centuries.*

Stavely is the Newcastle of the Derbyshire coal-field. The energies of Mr. Barrow are directed to the most extensive and successful coal-mining in the world. Nor is it less important in an agricultural point of view. A great part of its soil is the detritus of the rivers Dawley and Rother and their tributaries. It is well adapted for grazing and arable purposes, and all the family of cereals, legumes, and roots, flourish under a well-directed and active cultivation. The course of cropping will not vary much from that already given for the coal-series: the land is drier, and more turnips grown and consumed on the land by sheep. The turnips are grown on the Northumbrian system with farm-yard manure, bones, and guano. Lime is not extensively used, and chiefly on the wheat fallow, where its application is considered necessary to reduce the mechanical tenacity of the land. Notwithstanding the facilities of railway transit the quantity of lime used does *not* increase, a preference being given to bone and guano. This is the case generally where the land has been subject to heavy limings for years, more particularly the grass land, where bones have had the happiest effect in improving the herbage.

"I have not," says a large occupier, "made any special experiments with artificial manures, with a view to ascertain the relative value of each, but I have used most of them with various success, and the following are my conclusions:—

"For rough, turfy, old grass land; a dressing of from 6 to 8 tons per acre of Middleton Dale lime is the most beneficial. For grass where the herbage is short, and the quality wants improving, from 20 to 30 bushels of bone-dust is the most effectual way of doing it. I have seen a field covered with white clover after the application. Salt applied to wheat in March at the rate of 7 to 10 cwts. per acre, I have found increase the yield of corn from 1 to 2 loads of 3 bushels, although it makes no apparent difference in the amount of straw; but if examined it will be found clearer, brighter, and more healthy, than where salt is not applied."

On Mr. Barrow's farm winter beans are successfully grown, and the Defiance wheat has produced astonishing results. This wheat is gradually finding its way as seed-wheat, and its culti-

* The cost of making drain-tiles in this part of the county, including the first operation of throwing up the clay to drawing the tiles from the kilns and racking them, will average—

s.	*d.*			
22	6	per 1000 for	$2\frac{1}{2}$	inch bore.
30	0	do.	$3\frac{1}{2}$	do.
36	0	do.	$4\frac{1}{2}$	do.

vation annually extending, the produce having exceeded 7 quarters per acre.

Section of Ridge-draining; Surface.

Scale, 3 yards to an Inch.

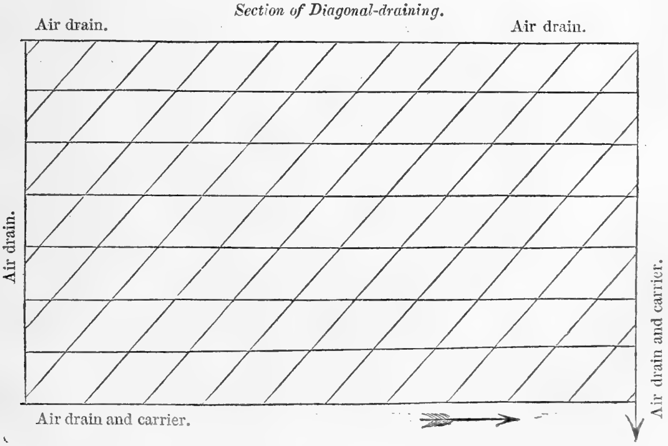
The estate of Sutton, with Sutton-cum-Duckmanton, comprising the entire parish of Sutton, is on the coal-series, and the property of Robert Arkwright, Esq. This fine estate came into the family possession 27 years ago by purchase, since which time continual improvements have been going forward. The soil is of various kinds and quality, abounding in minerals; the greater part being grazing and meadow land. The course of cropping having been given, it only remains to notice a few novelties observed in the course of these inquiries. According to Farey's Report, the celebrated Mr. Elkington was employed by the then possessor, Job Hart Price, Esq., to drain the estate in 1794 and 1795.* Elkington's system proved a failure, as it generally did on mineral soils, and his claims for compensation being disputed, it was left to reference. The plan of draining first adopted by Mr. Arkwright was the 2-feet-deep Deanstone system with tiles and stones, but it was only partially successful. The quantity of tiles required to accomplish this, and the many acres to be drained, was a serious money consideration. Accordingly it was determined to cut the drains across the lands from 10 to 20 yards apart, increasing the depth to 2 feet 6 inches. It is an opinion of Mr. Arkwright that "rapid percolation is injurious"—that "if the water is in motion only, and never allowed to stagnate all is done that is necessary." This plan was followed several years, and many thousands of tiles saved. Unfortunately for this system, the drains were too shallow and too wide apart. The plan had not a fair trial; but many acres of land chiefly on grass have received great benefit. The cross draining was continued, but the drains were taken deeper and at less width. This plan was followed for some time on the Sutton estate. Presently, and a few years ago, another system of draining was introduced by the proprietor, and as it is novel, and has some claims to originality, I shall give a section of it to make it better understood.

The plan is called ridge-draining, to contradis-

* Vide *Farey's Report*, vol. iii. p. 377.

tinguish it from furrow-draining, and may require some further explanation. It was thought desirable that one part of the old-fashioned practice of draining from the bottom, and up to the hill containing the water, should be attended to. Accordingly this plan was to be observed; but some difficulties presented themselves. The field to be drained was old grass, and set out in 5 or 6 yard lands. To drain this up every furrow was impossible, unless at a great expense, and the quantity of tiles required would exhaust any moderate supply. It was therefore proposed that the drains, instead of being taken up the furrows, should be taken up alternate ridges, as given in the section, through the whole field. The arguments advanced in favour of this plan are,—"that it is as likely to catch the springs by going up the ridge as the furrow;" "that the work is done at half the cost;" "that rain-water falling on the surface and the ridges soon finds its way into the furrow, and from the furrows, by percolation, into the drains." It is obvious that under this plan, where the lands are 5 yards wide, the drains will be 10 yards apart, but the collected waters in the furrows will only be 2½ yards from the drains; and if, to use Mr. Arkwright's own words, "the drains won't draw 5 or 6 feet, it is of no use draining at all." This, then, is the theory and practice of *Ridge-draining* versus *Furrow-draining*—a principle which appears to answer well, but may require time to confirm it in general estimation. My object in giving this explanation is to note the state of drainage as I find it, and not offer any opinion on its merits. Time will determine its advantages, and time will not wait. Before quitting the subject of draining at Sutton, I will briefly notice a plan pursued by myself in draining a field of cold, wet, and nearly flat close of land, near the edge of the magnesian lime.

Section of Diagonal-draining.



The lands were about 4 to 5 yards wide, and the drains, taken diagonally, 3 feet deep and 12 yards apart. The tiles were put into the drain in the ordinary way, and the materials returned into the *drain*, but in a somewhat different way. Wherever the drain crossed the furrow, a chimney of tiles was brought from the bottom to within 6 or 8 inches of the surface, affording a conduit to the collected waters in the furrows into the drains. The tiles were not placed vertically, but at an angle of 45 degrees—the lower tile resting on the drain tile, and the upper one on the lower in a zigzag form, thus. The field is a bad one, the clay impervious, and apparently without sand.

The stratum is generally of a mixed kind, conglomerated, and undetermined by any geological law. It frequently happens that, when a given quantity of drainage is effected in a field, the work is not complete: occasional parts of the field were found *springy* and full of water. Although this was discovered soon after the drainers left the field, yet no immediate steps were taken to remedy the evil. The drainers commenced operations over the hedge, and gave time for defects in former fields to show themselves; and, gathering experience as they went along, gradually succeeded in leaving but few defects behind them. It is a maxim on the estate that, having a certain sum per annum to expend in drainage, it is better to extend its benefits over a large surface than confine the outlay to a limited number of acres. All the fields drained are mapped in a book provided for the purpose, every drain given, and the mouth of it pointed out, the number of lineal acres drained, and the cost.

The tile-yard was established in 1832, and is one of the best of its kind, the floors of the flued sheds being of cast-iron. A small steam-engine grinds and puddles the clay, and prepares it for the tile machine. Upwards of 4,000,000 tiles have been made and laid down, on an estimated quantity of 2500 acres, at an average cost of 4*l.* per acre.

Since the estate came into possession, the farmsteads have been rebuilt or restored in a substantial manner. They are of brick covered with blue slate, having iron employed where stone is generally used. The window-sashes are cast-iron, burglar-proof; the window-sills weathered down to represent stone: there are cast-iron troughs, racks, and mangers; and, what is of the greatest importance, cast-iron spoutings to all the premises, carrying off the eaves-water into the well or cistern, and not suffering any water to wash or brew the manure except that falling immediately upon it.*

* The only liquid-manure tank constructed on the Sutton estate has lately been converted into a rain-water cistern.

Long Course Farm contains 480 statute acres ; the greater part being meadow and pasture land. From 15 to 25 acres of turnips are grown annually ; but the quantity is very much regulated by the weather, and the season for preparing the land, which is not the most favourable for turnip cultivation. All the fallow land not in a state for turnips is carried on and sown with wheat in the autumn. The new premises are well arranged and convenient. Inside the farm-yard is a pitched road round ; the manure-pit in the centre sunk in the ground about 2 feet. To prevent the rain-water falling on the road from running into and damaging the manure, the pit has a raised wall about 2 feet high, over which the manure from the stalls is thrown. Very little liquid runs from the manure-pit in the wettest weather, which joins the water falling outside on the road, and irrigates the land below the house. There is a plan of irrigation at Long Course now under trial, which appears at present to answer very well—that of using water issuing from drains. The idea is new, and, if it answers, will show that motion, or it may be friction, has much to do with the principle of irrigation.

The breed of cattle is mixed, as generally found in the county. About 70 head were in comfortable quarters, growing, and converting straw into dung of the best kind. This appears to be a plan not approved of in the southern part of the county. On the rich gravels and clays of that Goshen-land, the young stock is generally in the fields, *chiefly because the manure is not wanted, the land requiring none.*

Lime is burned on the estate ; the stone brought from Ashover or Middleton to the Duckmanton kiln : the colliery supplying the slack. The lime is sold to the tenants at 9*s.* per ton, being prime cost. It has been applied to the pastures with great success, at the rate of 5 tons per acre, costing in cartage and labour about 3*l.*, and had a most beneficial effect in sweetening the herbage and filling the land with clovers.*

These remarks on the husbandry of the coal-series will apply northward to the county terminus, embracing the parishes of Eckington, Whittington, Dronfield, Norton, and Beighton. The latter place is a portion of the Earl Manvers' estates, and generally a dry and open grit-stone soil, and particularly warm and sheltered, having the advantage of excellent meadows formed by the washings and detritus of the river Rother. In making a comparison between the husbandry and early harvests of Beighton with surrounding places, it must be remembered that the river there

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* A sort of rough tussac grass is common on pasture lands, which nothing will eat. It is locally called "bull-pate," and only destroyed by rooting up.

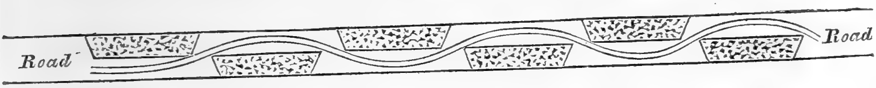
is only 180 feet above sea level. Dronfield Church, by the Ordnance Survey, is 472 feet, and Norton Church, on the borders of Yorkshire, 716 above the sea. This elevation, and the proximity of these places to the mountains of the Peak, and their icy exhalations, with the great quantity of rain falling, are serious impediments to successful cultivation. The altitude of Norton, in the northern parts of Scotland, would be the limit of the growth of corn: above that height the farmer trusts to pasturage for his returns. The time of harvest is very much affected by the elevation of the district. The county of Caithness, the most northern part of Scotland, is near the sea level, and grows abundance of wheat, and its harvests are little behind the Lothians and the Midland Counties of England.

Going north, the soil on the coal-series, excepting on the grit, does not improve in usefulness, and the greater part of it requires drainage. Its proximity to the great market of Sheffield, where every kind of farm produce meets a ready sale, enables the farmer to exchange commodities with the citizens of that great and flourishing town. Manure and brewers' grains are in abundance, and by this means the fertility of the soil is maintained. To these as fertilizers must be added horn-shavings, bone-dust, refuse from the comb-makers, and other animal wastes from the Sheffield manufacturers.

Use of Lime.—Having received a valuable communication from Mr. R. Booker, of Hazlebarrow Hall, near Sheffield, to whom I had last year the honour of awarding the prize given by the Norton Farmers' Club for the best-cultivated farm, I cannot do better than make a few extracts:—"Lime," says Mr. Booker, "as a manure is not so much thought of as formerly; it contains no ammonia or nitrogenous property; but its application to certain soils liberates the mineral and inert vegetable matter, which thorough draining materially assists. I am now applying lime to some newly-ridded woodland with success. It is still used, but with various results, on strong soils during the summer fallowing; it is also used with advantage on newly-broken-up land having a peaty soil replete with vegetable matter; also to old grass land, destroying the mosses and other sour plants, and producing a white clover sward. The application of lime is certainly diminished by high arable farming, *as frequent and deep stirring of the soil*, aided by thorough drainage, the use of bones, and other artificial manures, supersede its necessity." *On Draining*, Mr. Booker says, "I made a journey to Tiptree Hall a few years ago to make myself better acquainted with the mode of draining and general system of farm management practised by Mr. Mechi, and, following his example, commenced draining 4½ feet deep,

20 yards apart. *It was a failure; and I have since put in two 33-inch drains between, which has completed the work.* I now always drain 33 inches deep, because the men can do it at three draws." Mr. Lister, of Greenhill Hall, is of the same opinion as to depth and width, but continues the use of gravel over the tiles. Further on, and towards the extreme north-west of the coal-series, there are abundant evidences of mismanagement and neglect. It is true the land is poor and cold, but it has been subject to a system of exhaustion for many years. Nature intended it for pasture, but the design is changed and perverted.

Before quitting this interesting part of the coal-series, I cannot avoid making a few observations upon the continually-improved condition of the roads, and a new way of repairing them. The plan is practised on the Sutton roads, and is gradually extending. Perhaps the plan alluded to would be better understood by giving an etching of the way in which the roads are repaired.



The dotted parts represent the stone or iron cinder laid on the road: these layers are from 20 to 30 yards in length. The object attained is, that the heavy-laden machine going up hill has a clear, open, and smooth road; that it gets up the hill easier by taking a serpentine course, and throws for a while the wear on the roads from the centre to the sides; that the machine going down the hill is checked in its progress by rolling down the newly-repaired part; that the roads are better and wear level by this process, *and the cost of repairs is considerably reduced.*

3. *The Millstone Grit and Shales.*—This group of mountains is peculiar to Derbyshire and the west of Yorkshire. A century ago the entire ridge was an uncultivated waste, covered with heath and peat-bogs. It commences with the coal series a few miles north of Derby, near Duffield, and occupies a breadth of many miles, going north till it reaches the highest point in the county. Kinderscout is 1961 feet above the sea, and is surrounded by the *kindred* summits of Axedge, Mad-woman, and other elevated regions. The map annexed will correctly show the boundary and course of this formation. Millstones are supplied from its rocks; and it furnishes building-stones of the finest quality. The upper measures are composed of a series of grits and shales, which becoming exposed, the shales perish, and are destroyed like the face of Mam Tor (shivering mountain), and other places. The lower beds are close, and scarcely dis-

tinguishable, and from 20 feet to 30 feet thick, composed chiefly of mica, quartz, and feldspar, granular and fine-grained, from the destruction of igneous rocks, and washed and spread on the floor of an ancient ocean, till lifted by volcanic power to their present position. These mountains are the fountain-heads of the Derwent, the Wye, and the Dove; the two last flowing from the base of Axedge. The Wye finds its way through the grit to Buxton; then, penetrating the rocky vale of the carboniferous lime, joins the Derwent at Rowsley. The Dove is the county boundary on the west, and after two miles divides the Derbyshire limestone from the Staffordshire grit, and, when near Hartington, cuts through the limestone hills in Milldale and Dovedale. It then emerges from the limestone west of Ashbourne into the lowlands of the red marls and gravels.

The Derwent, and its tributaries, traverse an entirely grit and shaly country, more liable to destruction, carrying down the wastes from the shales in its peaty, brackish waters. Originally the meadows and lowlands in its course are indebted for their fruitfulness to the gravels, shales, sandsoils, &c. washed down in earlier ages. The soils on the grit from their nature are chiefly of a sandy kind, and sometimes of great depth, especially where the grits and shales occur. But where the outcrop of the more compact beds appears the soil is thin, and the rock the *subsoil.* In many parts the grit on Riber Top, Lea, and Tansley, the subsoil is of clay, and requires draining. The great difficulty of cultivating the grit is its clearance, and the removal of the rocks and blocks everywhere presented to the surface. Vast tracts have been cleared and taken in, and cultivation has encroached on the moor and the waste. In no part of the county has this encroachment been more judicious or better applied than a district west of Dronfield, towards Owler Bar, on the road from Sheffield to Baslow.

Mr. Haywood's analysis of this soil is as given below, and taken from land in the occupation of Mr. Greaves of Rowlee, in the woodlands of Hope, and near to the place where are the remains of ancient and unfinished millstones.

Mechanical analysis of millstone-grit soil: 100 parts contain—

Coarse silicious sand	33·380
Fine soil	26·000
Impalpable clay	33·000
Organic matter of the nature of humus	7·620
	100·000

Chemical analysis of the above:—

Phosphoric acid	
Organic matter in a state of decay	7·620
Water	3·600
Silicates containing ·515 of potash and ·206 of soda	82·641
Carbonate of lime and magnesia	·098
Alumina, oxide of iron, and manganese . . .	5·220
Phosphoric acid combined with alumina . . .	0·025
Sulphuric acid (combined)	·006
Chlorine, ditto	·002
Soluble potash and soda	·003
Soluble silica	·005
Loss	·780
	100·000

Note by Mr. Haywood.—"This soil contains a large quantity of mica which makes the percentage of potash so high. It would be benefited by lime, which promotes the decomposition of that mineral."

Throughout the whole range of the millstone-grit there are found occasionally patches and frequently many acres of a poor ferruginous soil, called from its colour fox-earth. Nothing will grow on this soil except the wild beech; and when it happens in a well-cultivated field it shows a "plague-spot" on the fair face of nature. The soil, analysed and given below, is from land in Mr. Greaves' occupation, on the confines of the county, and within an easy distance from the source of the Derwent. It may be interesting to compare this soil and the district in which it is found, being the extreme north, with other more favoured soils and climates in the sunny south, where the Derwent becomes a river of magnitude, and joins the "silvery Trent" at Shardlow.

Mechanical analysis of poor fox-earth from the millstone-grit: 100 parts contain—

Coarse silicious sand	46·800
Fine sand	9·000
Ferruginous soil	17·900
Impalpable clay	23·500
Organic matter	2·800
	100·000

Chemical analysis of fox-earth: 100 parts contain—

Organic matter in a state of decay	2·800
Water	6·900
Silicates, containing 0·50 of potash and ·022 of soda along with pure silica	85·700
Alumina—Oxide of iron and manganese . . .	4·048
Carbonate of lime and magnesia	·010
Phosphoric acid	·002
Sulphuric acid, chlorine, soluble potash, and silica .	not distinguishable.
Loss	·540
	100·000

Note by Mr. Haywood.—"This soil is deficient in all those ingredients which are most essential to the growth of plants. It does not contain the usual potash minerals in any quantity, so that it is impossible to grow good crops with any tillage which does not contain all the ingredients which plants require, not even excepting potash and silica."

"The soil on the millstone-grit is as variable as its climate; and it is nearly impossible to define the husbandry followed. Every occupier is influenced more or less by the climate and locality, and follows a plan laid down by himself. On the south of this formation there is fine grazing and pasture land; higher up the hill the land is more exposed, yet produces excellent crops of turnips, barley, and wheat. The rock is near the surface, and the land is naturally dry. The following is the course of cropping usually followed on the southern side:—First year, fallow, turnips; second year, barley; third, fourth, and fifth years, seeds mown first year; sixth year, wheat; seventh year, oats. The turnips are grown annually with 2 qrs. of bone-dust and 2 cwt. of guano, drilled on the ridge, at a cost of about 3*l.* per acre. Lime is used on all the fallows, both wheat and turnips, at the rate of from 3 to 4 tons, and greatly benefits the land, particularly the clovers, and thus in practice confirming the theory of the chemist.

The principal proprietors on the grit are the Dukes of Rutland and Devonshire, each having extensive estates. On the cultivatable land the work of drainage is going on, and a heavy amount of tiles annually deposited at a maximum depth of 3 feet. The drainage of the Rutland estates is very extensive, and some years ago was under the superintendence of Mr. Smith of Deanston. His plan was not successful in effecting a thorough drainage of the land, and it was ultimately abandoned—a deeper system introduced—and a tile-yard established at Rowsley. About 3000 tiles per week are made and sent out from the tile-yard to the works of drainage going on in different parts of the Haddon estates. The drains are cut at the common prices before described for the coal-series, and there is nothing of novelty to notice in the *modus operandi* farther than I may state, from personal observation, that *the work is well done.* Small pipes are very properly condemned, and nothing less than 2-inch bore used. The cost of draining, including the cost of tiles, cartage, &c., will be about 5*l.* per acre: this outlay, with the drains averaging 3 feet deep, will give a width of drain from 30 to 40 feet.

The farm and estate of W. P. Thornhill, Esq. of Stanton, are thoroughly drained, and, considering the altitude, the climate, soil, &c., and other physical difficulties, must receive a passing

notice in a report of Derbyshire farming. Stanton-house is 715 feet above the sea-level; and the farm shows what may be done in *defiance* of difficulties by an outlay of capital and labour in reclaiming the waste. A great part of the farm has lately been taken from the moor at an average cost of 15*l.* per acre.* The first process was the draining at 18 to 20 inches deep, 6 and 7 yards apart. This was found insufficient, and deeper drains, from 3 to 4 feet put in, and a perfect, though expensive drainage completed. The cropping followed at Stanton is the four-course; and beginning with the first year, turnip, fallow; second year, wheat or oats; third year, seeded, and occasionally mown; fourth year, wheat. The turnips are grown with bones and guano, and a heavy dressing of farm-yard manure. The bulk of them is consumed on the land by sheep purchased in the autumn, chiefly of the Leicester and Shropshire Down breed. The wheat is sown after the turnips up to Christmas, and the remainder of the turnip-land with oats in the spring. The average produce of the oats may be taken at 7 qrs. to the acre, and wheat at 4½ qrs., of excellent quality.† Many calves are reared on the farm, and a considerable dairy of useful cows fed on linseed and rape-cake, with hay and turnips. Rape-cake was given to cows for the first time last year; but the bailiff said, "Rape-cake was better for sheep than cows." On the top of this hill every kind of implement may be found, from the Bedford plough to the drill and clod-crusher. Favoured by a southern aspect, and sheltered from the north and westerly winds by extensive plantations of larch and spruce, the farming at this elevation is under favoured circumstances, and very different to the opposite hills facing the north and east. It may be a question of importance how far beneficial the plantations have been to agriculture at Stanton. At this elevation in no part of the midland counties has autumn wheat been successfully grown, while in the Peak, and near the mountains, wheat is never attempted at elevations from 100 to 200 feet below.

The Derwent flows through the vale of the millstone-grit, whose mountains supply its tributary streams. Chatsworth-house stands on its banks. The greater part of the park and the land at Edensor is on this formation. It is at once good land and useful for pasture and arable purposes. The best crops of turnips and roots are grown on its soil, and it is no less famous

* One portion of Stanton Moor cost 50*l.* an acre, in stubbing, ridding, and blowing up grit rock.

† In the South of France, according to De Candolle, wheat is cultivated at 5,400 feet above the sea, rye at 6,600 feet. The limit of corn cultivation in the Alps is 3,800 feet.

for its meadows and pastures by "*the Darren side.*" The farm at Chatsworth under the care of Mr. B. Swaffield, having exerted a beneficial influence by its annual sale in disseminating a higher breed of animals, must receive in a Report of the Farming of Derbyshire a proper attention. The farm is described by Mr. Swaffield as "consisting of 760 acres, one-fifth being arable, and the remainder meadow and pasture land. Of this farm 235 acres are on the East Moor, having a peaty soil, occasionally intermixed with clay. The entire farm is widely scattered, and the soil various, the elevation from 400 to 700 feet. The greater part is on the millstone-grit, and with 170 acres of rich grazing land on the mountain lime at Crakendale completes the farm. About 250 acres of grass are mown for hay every year, commencing on or about the 28th June. The hay harvest employs many Irishmen, who go southward when it is completed to find employment, and afterwards return to assist in cutting the corn. The only artificial manures I am in the habit of using are guano and bones. I have tried superphosphate, but to no extent. I always grow my turnips with burnt heath sods, mixed with the bones at the rate of 3 qrs. to the acre, and a slight dressing of guano, sown broadcast after the land is opened for ridge: the whole is closed in the ordinary way, and then follows the drill. The climate is not favourable to the growth of wheat except in the valleys, where excellent crops are obtained, and in dry and fine seasons of good quality. Barley is seldom grown here: the last year an experiment was tried with the skinless Peruvian, and the produce exceeded 10 qrs. to the acre. Sheep are kept of various breeds. A great number of woodland and Scotch wethers are grazed annually: their mutton is of the finest flavour. Independent of the land before named, there are 300 acres of pasture (Calton Leys) appropriated in the summer to ley cattle; and in the winter from 200 to 300 horned sheep are kept there, and sold off the following autumn. A flock of about 200 breeding Leicester ewes are kept. There is a small herd of short-horns on the farm. The grazing cattle are principally bought; and 200 head of short-horns and Scots are grazed and sold, chiefly at the annual sale." These important and well-conducted sales are now over; and it may be well more particularly to describe them over a period of fourteen years, during which time they have realised more money than the annual sales at Woburn or Wentworth.

				£.	s.	d.
The first sale	took place in	1839,	and produced	806	9	0
,,	,,	1840	,,	1525	10	6
,,	,,	1841	,,	1834	1	0
,,	,,	1842	,,	1613	14	6
,,	,,	1843	,,	1761	19	0
,,	,,	1844	,,	1580	2	0
,,	,,	1845	,,	1902	18	0
,,	,,	1846	,,	2507	3	6
,,	,,	1847	,,	2287	8	0
,,	,,	1848	,,	2121	12	0
,,	,,	1849	,,	1882	4	0
,,	,,	1850	,,	2075	4	0
,,	,,	1851	,,	2080	12	6
,,	,,	1852	,,	2251	6	6
		Total		26,230	4	6

Giving a general average per year of 1873*l.* 11*s.* 9*d.* Besides the select animals sold as in-calf heifers, many first-class bulls and bull-calves were offered to public competition. One bull-calf realised 130*l.*; and the highest price made for a fat Lincoln ox was 70*l.* To obtain this high blood and pedigree, high prices had to be given; and purchases were made from the herds at Castle Howard, and Wiseton, and from the Messrs. Parkinson, Booth, Bates, Watson, and Whitaker. The cow, Myrtle, cost 150 guineas; and two cows, one bull, and one yearling heifer, cost 312*l.* at the Earl of Carlisle's sale. One of these cows cost 87*l.*, and had three calves afterwards. Connected with this cow, it is a remarkable fact that nature made no provision for the calf, and after calving the cow never gave *any* milk. It is the opinion of Mr. Swaffield—and this opinion is confirmed by Mr. Gregory of Meadow-place, Mr. Greaves of Bakewell, and other farmers and breeders, in the course of these inquiries—"that to pamper and force a young animal, either male or female, is to destroy its usefulness. The former loses its power of procreation; while the latter will not give sufficient milk for the maintenance of its calf *The same animal, if kept in a state of nature, would better answer the purposes intended by nature, and be more useful to man.*" It may be for these reasons the dairyman on the upland farms is slow to use the Durham blood, from a belief they are less hardy and less useful. One farmer, at once respectable and intelligent, Mr. Greaves of Bakewell, stated "he would challenge the old-fashioned long-horned breed of the county against all the new blood that had ever been introduced." But this was for dairy purposes: he did not contend that early maturity was so soon attained by the long-horns, but admitted that for the shambles no breed made so much beef in so little time as the short-horns. These are truisms and established facts; and it is no less true that the pampered short-

horns, when exposed to the pelting storms of the Peak, or the evils of *poverty*, show their unfitness and power to bear against it. With the introduction of the short-horns was also introduced better care in rearing and feeding, better houses, and better drained lands.

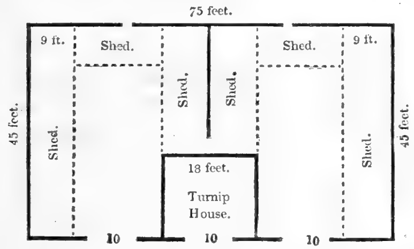
Highland Scots and galloways are usually purchased in the autumn at Brough Hill fair, and pastured on the mountains during the summer, and brought into the more sheltered quarters of the lowlands in the winter. These animals are rarely stall-fed. At 3 and 4 years' old they are fine beef, and command high prices. The Scots are hardy, and not subject to the diseases common to animals that have been driven and brought from a distance.

The course of cropping pursued by Mr. Swaffield are,—1st year, fallow for turnips, swedes, and mangolds; 2nd, wheat or oats; 3rd, seeds mown; 4th, pastured; 5th, wheat; 6th, oats. On a portion of the farm, inclining to soil of a peaty nature, rape is introduced after the fallow, and seeded down for four or five years of pasture, and ploughed up for oats. Mr. Jephson, of Chatsworth Inn, introduced last year, after turnip fallow, a crop of April wheat, the produce of which was equal to the ordinary Lammas wheat grown in the neighbourhood.

In the neighbourhood of Chatsworth may be found some fine animals of the short-horn blood, descendants of the stock bred at Edensor farm, and annually disseminated by the sale. On the Birchills farm, occupied by Messrs. L. and G. Furniss, and belonging to the Duke of Devonshire, some good animals are kept, and a dairy of cows. It contains 300 acres, and is well cultivated. Lime is applied to the fallows at the rate of 5 or 6 one-horse cart-loads to the acre, each load containing about 16 cwt., the cost at the Calver lime-kilns being 5*s.* per ton. In the growth of turnips, 2 quarters of bone-dust is drilled on the ridge, over 8 or 9 tons of manure per acre. Previous to the closing of the ridges, 2 cwt. of guano are sown broadcast over the manure. This will cost in artificial tillages only about 3*l.* an acre, independent of farm-yard manure. Lammas wheat follows the turnips so long as the weather is favourable for sowing, and April wheat or oats completes the sowing of the turnip land. A good flock of Leicester ewes are kept, and a well-contrived sheep-shed is on the farm. These sheep-houses are of such growing importance to upland farms that I give the plan of the one at Birchills, which will accommodate 100 sheep.

During the cold season the sheep are housed every night, but not always fed: in the morning they are turned out on the grass, or fed with turnips. The bulk of the turnips are eaten on the

ground with sheep, and fenced in the usual way; and the first draught of fat hogs will be sold in May, and average 72 lbs. each.



Mr. Haywood's analysis of shale soil, taken from a field on the west side of Birchills, and near the Hassop estate, is as follows:—

Mechanical analysis: 100 parts contain—

Coarse and fine sand	17·500
Fine soil	35·600
Impalpable clay	40·000
Organic matter of the nature of humus	6·900
	100·000

Chemical analysis of shale soil:—

Organic matter (humus) in a state of decay	6·900
Water	8·100
Silicates, containing ·849 potash, and ·650 soda, lime, and magnesia	71·129
Alumina—Oxides of lime and manganese	12·750
Carbonate of lime	·870
Do. of magnesia	·130
Phosphoric acid (combined with lime)	·110
Sulphuric acid (do.)	·002
Chlorine (combined)	·001
Soluble potash and soda	·004
Soluble silica	·004
	100·000

Analysis of shale substratum:—

Bituminous nature	11·80
Silicates, containing ·34 of potash and ·12 of soda	49·40
Carbonate of lime	3·20
Do. of magnesia (a trace).	
Phosphate of lime	·12
Sulphuret of iron (a trace).	
Oxide of iron and alumina	3·20
Water	2·80
Loss	·48
	100·000

Note by Mr. Haywood.—" This soil contains potash minerals in abundance, which when acted on by lime are rendered soluble; hence lime (which has

been extensively used) will here be of great service. It will also have the effect of neutralizing any acids which the sulphuret of iron in the subsoil may give rise to. Phosphates are here present in abundance, and it is very likely that bones may not be found of much use. Common salt and ammonia the best tillage; gypsum not required, being constantly furnished by the subsoil."

It does not appear that any of the manures referred to by the chemist have been used; but, from the analysis, the soil is adapted for the growth of clover. And practice confirms science —clover sickness is unknown; and this capricious plant never fails.

Before leaving this part of the county notice must be taken of the Portland Estate, situate on the East Moor. It contains 507 A. 3 R. 16 P., chiefly a black peaty soil, resting on a potter's clay, and came into possession by purchase in 1829: since which time it has been reclaimed, drained, fenced; plantations have been made, and farmsteads erected. By the favour of Charles Neale, Esq., of Mansfield Woodhouse, I am enabled to give a few particulars of the outlay on this property, which is, without any doubt, the most prominent feature in the county of the improvement of waste lands. As the traveller first descends the hill from Chesterfield to Baslow he will have observed to the left this property, and the continued improvements to which it has been subject for more than twenty years, affording evidence what may be done by capital in surmounting the physical difficulties of soil and climate. "The greater part of the draining was cut up the hill in the furrows, 3 feet deep and about 6 yards apart, and cost about 5*l.* 17*s.* per statute acre. Where the drains were cut through peat or black soil *the land has subsided nearly 2 feet;* consequently, those parts have had to be redrained 2 feet deeper, and have effected great improvement. The clay thrown out by the deeper drainage is spread on the peat surface, and has been of great benefit. *Deep* drains on the hills were made *first*, 8 feet deep, catching the springs, and discharge a large quantity of water during the summer months, long after the furrow drains have ceased to run. About 883,750 tiles have now been put down; and the total cost in draining the estate is 5094*l.* 12*s.* 10*d.*, or 10*l.* 13*s.* 6*d.* per statute acre.

£.	*s.*	*d.*		£.	*s.*	*d.*	
2000	17	4,	or about	4	0	0	per acre, expended in fencing, walling, plants, &c.
897	9	3,	or	1	16	6	per acre, in cultivation, ridding, stubbing, &c.
192	15	2,	or	0	5	6	per acre, in roads, bridges, watering-places, &c.

The total cost of farm-buildings, which are entirely new, has been about 9*l.* per statute acre. Up to Lady-day, 1841, when the whole of the estate had been brought into cultivation, the sum of 25*l.* 15*s.* 6*d.* per statute acre had been expended in preparing the moorland for the occupation of tenants."

Considering all the difficulties of soil and climate, the hand of industry has had much to contend with; and physical force, supported by a liberal outlay, could only accomplish it. The estate is at the present time under active cultivation, and, by the judicious application of mountain lime, produces abundant crops. The course usually followed on these reclaimed peat earths will be,—1st year, fallow—turnips and cabbages consumed in the fold-yard by cows and young stock, or sheep on the seeds; 2nd year, barley-bere, or barley-big, giving 5 quarters per acre, and occasionally used for malting; 3rd year, seeds; 4th and 5th years, seeds pastured and broken up for two crops of oats. The drainage, the clay, and the lime have a beneficial effect on the peat: it is less spongy, and more like ordinary soil; and, by autumn dressing and cleaning, 6 and 8 white crops have since been taken.

There has been a similar reclamation on the estate of Robert Arkwright, Esq., at Harrod, on a continuation of the same strata, running east. Rocks have been split up and converted into farm buildings and fence walls, and the land drained at the average cost of 19*l.* per acre. These improvements, made and making, are proofs that agriculture in Derbyshire is not stationary. Extensive plantations have been made in this district, chiefly of larch, spruce, Scotch fir. At Darley Flash, on the estate of the Rev. — Jebb, of Walton, noble specimens of soft timber are growing, approaching in dimensions to the pines of Northern Europe.

Going north towards Hathersage, Bamford, Hope, and Castleton, the district does not offer any agricultural novelty. It is chiefly pastoral, and in the summer very beautiful. Oats and turnips are the principal crops on the arable lands: the meadows yield good crops of hay. The stock is a mixture of short-horns and the ordinary stock of the district: they are not, generally speaking, well attended to and cared for. This is owing chiefly to the want of comfortable houses and sheds: they are turned out "*where there is plenty of room*," laying their manure where it is not wanted. Farther north, the vales of the Derwent and the Ashop are narrow, and afford only in many places a pass for the stream and the road. The meadows, where there are any, are only strips of land, subject to the mountain flood, but giving good crops of hay. Efforts are continually being made to enclose the land and blow up the rocks to make fence walls, and catch an acre where it is practicable to grow roots and oats. To all these industrial efforts there are many difficulties and drawbacks. The seasons are critical; the winters long; showers and snow-storms continual, with frequent hail. The enclosed patches are subject to certain lawless freebooters, with long horns and a longer tail, and typical of the famous *Derby ram*, read of in nursery rhymes.

These sheep mount the walls in spite of the husbandman, and damage or destroy the coming crop. Nothing can be more provoking, and the only remedy against their incursions is to chain two together by the horns.*

Mr. Robinson, of Ashopton, and Mr. Greaves, of Rowlee, have crossed the horned ewe with the Leicester ram for some years, and state they intend to continue it. But it is agreed that the native woodland sheep is best adapted for the unenclosed upland moors. This breed has existed in its native purity from time immemorial, and will, in all probability, continue. In 1810 (*v.* Farey's Report, page 88, vol. iii.) "the Duke of Devonshire placed 3 Merino rams in the care of Mr. Charles Greaves, of Rowlee, for the improvement of the Woodland fleece." About that time a great rage appeared in every part of the country to introduce the Merino, and its fine quality of wool. But it appears not to have succeeded, and presently was given up, the Woodland breeders being satisfied with the experiment. Mr. Greaves says, "There are some useful half-bred Leicester and Woodland sheep, that answer well in the lowlands,"—"they don't do well on the mountains,"—"my wool sold this year for 14*s.* per stone, and my sheep average about 4½ lbs. each,"—"on all the newly-enclosed land lime is a most valuable manure, but on the older and worn-out soils it is worthless." The course of cropping in this part will be, 1st year, fallow, turnips; 2nd year, oats; 3rd year, mixed clover-seeds, and held in grass for 3 and 4 years, and ploughed up for oats. Bones have found the way into the mountains, and the turnips are grown with from 12 to 15 bushels of dust per acre, or from 3 to 4 cwts of guano. Flat drilling is preferred, but they are sometimes sown broadcast. Sometimes rape and seeds follow the turnips, as practised on the mountain lime. Farther on to the north-west the hills offer little that is noticeable to the agriculturist. The summit of the British Alps in Derbyshire is, for several miles, a level morass, and the fountain-head of two streams running east and west, the one finding its way to the Humber the other to the Mersey. Descending the hill towards Glossop, and forward to Dinting Vale, Derbyshire there is a manufacturing district.

4. *The Carboniferous, Marine, or Mountain Lime.*—By a reference to the map, and to the description already given of the millstone-grit, which nearly surrounds and encloses it, the boundary of this formation will be given. It emerges from beneath the grit above Cromford, and is traceable by the Middle Peak and the crags south of Wirksworth to Hopton, Brassington, Bradbourne, and Thorpe, where it crosses the Dove and enters

* It is related that these horned sheep have been known to butt against a wall, after a "battering-ram" fashion, to get into a turnip field.

Staffordshire. Its hills on the south and west form lofty moors, fit for sheep-walks, but in many places forming good pastures. The mountain-lime gives the Brassington pastures, Tissington pastures, Taddington pastures, Haddon pastures, and the rich grazing and dairy farms on the banks of the Dove, from Tissington to Alsop, Hartington, and forwards up the stream to the summery meads of Pilsbury Grange. On the tops of many of the hills are level plains, and there is great difficulty in procuring water for the stock. The open limestone rocks will not hold water without some artificial means of catching and preserving it. Meers are constructed, a circular basin, puddled with concrete, clayed and paved to retain the rain-water frequently thrown in by sluices or *offsets* from the public roads. The limestone which occupies the centre of the High and Low Peak, consists of an immense series of beds. In the upper series, for about 60 feet thick, they are of various colours, chiefly grey, interstratified with thin silicious beds of chert or flint, analogous to the flints in the chalk, and below these lie the grey marble beds, quarried and used for ornamental purposes. After these comes a very thick bed or beds of crystalline grey limestone, burnt for lime, and used extensively for fluxing iron-ores in Staffordshire and Derbyshire. Below this that extraordinary measure called toadstone or basalt is found, resting on its bed of plastic clay. These measures are seldom covered with a deep soil. But where the toadstones occur, and where, after perishing, it is washed down into the slopes and hollows of the lime, a deeper, better, and more tenacious soil is found. On the limestone basin about Newhaven, Newbiggin, Pike Hall, &c., which is free from rocky precipices, the soil is good, with an inferior clay subsoil beneath it, where farming is carried on with some success. But the best lands are found along the margins of the limestone, the grit, and the shale, where the detritus of each by river action has been blended together, producing a fruitful soil. This soil is always dry, and requires no draining; but the limestone shale, which generally forms its own soil and subsoil, is wet and retentive.

To describe its husbandry will be no difficult task, as its soil is chiefly employed in grazing, and very little corn is grown. Its pastures are very rich in all the elements of vegetable and animal life, and produce beef, mutton, and cheese in abundance, and of the best quality.* The mountain limestone soil analyzed is taken

* It is estimated the quantity of cheese produced in Derbyshire is 10,000 tons per annum, of which the greater part is made on the mountain lime. If it requires one cow to produce on the average 3 cwt. of cheese, it follows that 50,000 cows are employed for dairy purposes. The average price of cheese bought at Derby in the fairs and markets (taken from the books of a factor) for 14 years last past is 55*s.* 3*d.* per cwt.

from a field at Ashford, near Bakewell, in the occupation of Mr. Green, and is as follows.

Mechanical analysis: 100 parts contain—

Pebbles of chert	3·617
Coarse and fine sand	15·400
Fine soil	57·500
Impalpable clay	12·125
Roots and fibres in a state of decay	·158
Organic matter, principally humus	11·200
	100·000

Chemical analysis:—

Organic matter, with roots and fibres named above	11·358
Water	7·200
Stones not analysed	3·617
Silicates, containing ·480 of potash and ·220 of soda	68·800
Alumina—Oxide of iron and manganese	·341
Phosphoric acid (combined with lime)	·008
Sulphuric acid (do.)	·002
Chlorine	·001
Soluble potash and soda	·003
Soluble silica	·002
Loss	·248
	100·000

Analysis of mountain limestone below the soil: 100 parts contain—

Pure carbonate of lime	98·60
Carbonate of magnesia	a trace.
Silicates, containing potash	·20
Alumina—Oxide of iron and manganese	·14
Phosphate of lime	·46
Bituminous matter	·21
Loss	·39
	100·00

Note by Mr. Haywood.—"It will be seen the soil itself contains only a small amount of carbonate of lime, the whole having been removed by carbonic acid and water. Phosphates are also deficient, having been appropriated by the animals in the formation of bone. I can, therefore, understand why the addition of lime (which contains both these ingredients) to these soils should always be attended with good results."

Mr. Haywood might have added that "Bones applied would be equally good or better;" for it appears from all the collected evidence on this matter that bones on these soils are superseding the use of lime.

The analysis of the soils will, in some degree, describe their character: they are chiefly a brown-hazel mould resting upon the rock, and the variation in the depth determines the richness of the land. The higher and poorer parts are a blackish-looking soil, inclining to peat, upon a red loam, intermixed with a coarse

sand and gravel. The greater part of the draining is completed, particularly those portions as belonging to the Devonshire estate.

The course of cropping on the mountain lime is nearly uniform, and confined to the growing of turnips, rape, clover seeds, and oats, with occasionally wheat and bere (big), and is as follows:—

1st Year.—Fallow, turnips, roots, &c.
2nd do. Oats or rape.
3rd do. Seeds, mixed clovers, with 8 to 12 bushels of natural hay seeds.

In this state and by the mode of laying down the land on rape, the seeds are pastured from 14 to 16 and 18 years, and ploughed up for oats, the land improving by the rest. Natural grasses are indigenous to the limestone soil, and the couch grasses with ordinary care in the fallow rarely show themselves. The turnips are generally drilled on the flat, with improved machinery, and receive from 2 to 4 quarters of bones per acre with ashes, and from 2 to 3 cwt. of guano sown broadcast. On the best-cultivated farms the manure is reserved for the seeds and the meadow lands. The turnips are not consumed where grown by sheep, but carted on to grass lands during the winter. One reason given for this plan is, that "owing to there being so little soil, it is impossible to fence them by nets or fleaks in the usual way." Another reason given is, "that the sharp pieces of chert are continually cutting the sheep's feet and producing inflammation and foot-rot." Perhaps the best reason for this practice will be, that in these showery regions the sheep are more comfortable on the grass with cleaner food and a better layer. Many of the upland farms are large, and from 400 to 800 acres, keeping a flock of breeding ewes and rearing great numbers of calves every year. Since the epidemic, which has been attended with heavy losses to many of the farmers, greater numbers of calves have been reared; because it is found that animals bred on the land are less liable to disease *of all kinds*, than those which have been driven from fair to fair. On the extensive farms of One Ash and Meadow Place from 30 to 40 calves are annually reared. They are subject to the quarter evil, or speed (sometimes called black leg) which attacks them in the legs, for which there is no remedy. As a prevention to this evil, for it is an evil of magnitude, the young animals are rowelled in the dewlap, and suppuration kept up during the cold season. The disease is not now so common as it was 20 years ago. The calves are better reared and cared for, their blood is in a more active and healthy state; but the greatest reason why the quarter evil is less frequent is, that they are now kept in fold-yards or houses, of late years provided. Dairy cows are subject to red water when pastured too long on the black soil, particularly

when they are strangers. The best remedy is to change the pasture frequently. Mr. Stephen Glover, of Middleton, says, "As regards the breed of cattle, their object (the farmers') is to obtain quantity and quality for the production of cheese and butter, and such as will come to early maturity for the butcher. And I think for really useful purposes, for symmetry and breed, this township for its extent may challenge the county. In their sheep stock you may average them with the generality of Peak farmers." This township (the township of Middleton by Youlgreave) is "a gem of the Peak," and has the enviable reputation by general consent of being the best-managed estate and having the best farmers in the county. The practice of seeding down land with rape after turnips, though not introduced in the first instance by the late Thomas Bateman, Esq., was approved of by him, and its adoption insisted on by his tenantry. This plan gives two green crops and two fallows, and the land must necessarily be clean and in a high state of cultivation. The practice is common on the mountain limestone, and is really high farming; repelling in a great degree the libel "that Derbyshire proprietors are indifferent to agricultural progress." A great breadth of meadow-hay is grown on these soils, and most of the farmers have hay-making machines made by the village carpenter: they are simple in construction, without springs, and answer all the purposes of the more expensive machines. Those employed on the farm of Mr. Gregory, Meadow Place, are worth notice.

The Hon. G. H. Cavendish, M.P., Ashford Hall, has favoured me with an account descriptive of his farming operations at Ashford Hall, near Bakewell:—

"The farm consists of 150 acres of land, of which 40 acres is arable. The arable, a good soil from 10 to 12 inches deep, has most of it been ploughed deep, some trenched, and recently obtained the prize given by 'The Bakewell Farmers' Club,' as the best-managed farm:—

	Course of Cropping.	Weight and Quantity of Crop.
"1st Year.—	Oats after seeds	8 to 9 quarters per acre.
2nd* do.	Wheat	About $4\frac{1}{2}$ to 5 quarters ditto.
3rd do.	Turnips and mangold . . .	About 20 tons.
4th do.	Winter barley (sown in October) .	9 to 10 quarters per acre.
5th do.	Seeds generally mown twice for hay.	

"The great bulk of the farm-yard manure is put on the seeds and meadow-land. The winter barley stands up well, ripens early, and the seeds grow remarkably well underneath. This barley fetches (1853) about 28 shillings per quarter, and when proper pains are taken in its cultivation seems to be a crop well

* A better sample of wheat is grown after oats than after a green crop, where it is too liable to run to straw.

suited to this high district. The wheat grown is seldom a first-rate sample, but wheat straw is of itself of great value in this part of the county. A herd of 15 Ayrshire cows and heifers, besides 9 short-horns, were kept last summer: they did not average 5 lbs. butter each per week last year. Those which calved shortly after arriving from Scotland did not milk well. Some have calved a second time and milking much better. We consider that 5 Ayrshire cows may be kept where 4 short-horns are. The milking cows are fed in winter on Swede turnips, hay, a few grains, barley and linseed compound with chopped hay. A flock of 35 to 40 Shropshire ewes do remarkably well, though more subject to foot-rot than others. In 1852, 37 ewes reared 63 lambs; of these 7 lambed the end of February; suckled 12 lambs which were sold at Easter for 1*l.* each. Four ewes were killed between September and Christmas averaging 94 lbs. each, and had 92 lbs. loose fat; of the other 3 no account was taken. About 6 years ago tried Leicesters in a shed—3 in a pen; got very fat, but did not pay. Since that time have had 20 hogs in the shed, 10 put together; they have done very well—they consume each about 10 lbs. of turnips per day with a little hay. The advantage found is, that they are very healthy, grow faster, have made wool, and the other sheep do better on the grass without them. Some Shropshire hogs wintered in the shed 1851 and 1852, afterwards fed on grass, averaged at 18 months old 25 lbs. per quarter. In 1848-9, December 1, put 8 sheep in shed, gave them each per day 14 lbs. Swede turnips, a little hay, and 1 lb. of cake. They were shorn February 1, weight of wool 8 lbs. each. Each sheep had a pint of oats per day for the 4 last weeks. They were sold the middle of March, when they averaged 11½ months old, and weighed as given below:—

	lbs.	
"One Leicester	80	
Ditto	70	
	—	150
One half-bred Leicester and Haslingdon	82	
Ditto	80	
	—	162
One half-bred Leicester and Shropshire	84	
Ditto	76	
	—	150
One half-bred Leicester and Woodland	101	
Ditto	90	
	—	191

"Pigs kept from March 25, 1852, to September, on skimmed milk, allowing for each cow's skim-milk 1*s.* 6*d.* per week, fed on pea, barley, and oat-meal, and charging for attendance, and every other item, showed a small profit besides all the manure. 4 pigs, 11 months old, made 33*l.* at 5*s.* 6*d.* per stone."

The experiments of Mr. Cavendish are very interesting and valuable, from which may be deduced some facts; and there may be put at the same time a few interrogatories. Why is the blood of Myrtle and Nelson, the purest and best of the short-horned race, abandoned for the Ayrshire? Is it because the Ayrshire makes the most beef? or is it because the short-horns consume too much food and misappropriate the same by converting it into tallow? One of these, or both, or neither, may be the reason; but what is the fact? that in the nineteenth century we still require experiments to prove the superiority of one over the other. Would the short-horn become (in course of time) an Ayrshire if taken to the "Banks of Bonny Doon?" or would the *horns* of the Ayrshire grow shorter by travelling south and indulging in the pampered dietary of the luxurious short-horn? If it be true that *all* beef and mutton goes in at the mouth, and that the animal economy is only a means of conversion, the best test for deciding this all-important question would be to turn out, at 4 months old, 2 calves—one of the Ayrshire, the other of the short-horn or Durham blood, and determine by figures and experiment which would give the most milk, or convert, from the same money value in vegetables, the greatest amount of milk, or beef, or butter, for the use of man. The experiment with sheep is most valuable, inasmuch as it shows that without muscular exercise muscle and flesh cannot be produced. The 3 Leicester sheep that were put into a straightjacket, penned, and well fed, "got fat, but did not pay." But the 10 hogs put into the shed, "have done very well," because they have room for exercise.* The weather had no influence in reducing their comforts, and the experiment shows sufficiently the value of sheep-sheds in high and upland farms.

But the most valuable experiment has yet to be noticed. Eight sheep of mixed blood were for experiment put into the shed. Putting them in pairs, *the Leicesters*, and *the Leicester and Shropshire*, were equal; but the others, the mixed Leicester and Haslingden, the Leicester and Woodland, gave heavier weights on the scale. As a practical man, I am at a loss to understand this. It might have been supposed the half-bred Woodland with its horns and erect ears, would have brought its wild and predatory habits. It seems, however, the Woodland breed made more mutton than the Leicesters, or the mixed Leicester and Shropshire. Perhaps it brought into the shed its long-established and hereditary muscle.

The land at Ashford is of excellent quality. Ascending the

* Mr. Cavendish's shed is simple and useful, costing very little, but answering every useful purpose. It is box-feeding sheep, without boards. The animals are on straw, and have comfortable lodgings and plenty of room.

road to Buxton, the rock is near the surface and the climate colder, yet affording good summer pasturage for all kinds of stock. On these mountain pastures there are no insect tormentors, and on the hottest days the cattle mount the highest hills, or bathe in the rivers. The stock on the barest hills, where the rock is naked and craggy, are frequently the Highland Scot, who travelling south enjoy themselves in a warmer climate.

Following the line of the Peak Forest Railway from Buxton to Cromford, a distance of 25 miles, the country is undulating and mountainous, but rich in pasturage, and the land generally dry. The arable is of limited extent, and is chiefly useful to the farmers for the straw and the turnips. In describing the cultivation of the arable soils of this part of the county, I shall follow the particulars given me by a gentleman many years a resident:—

"Nature has given but a scanty covering of soil in this district, yet the farmers are able to grow good crops of oats and turnips; and were the climate less severe, no doubt the northern farmer would be able to compete with his more fortunate brother who is domiciled in the southern part of the county. Where any system is at all pursued, the first step in growing turnips is to prepare a clean fallow in the usual way. The couch-grass and root-weeds are gathered and carted to a vacant corner of the field, either to be burnt, or to undergo the more approved practice of mixing with hot lime, and, after being turned several times, put in its reduced state upon the young seeds. Most farmers now drill their turnips on the flat, with from 3 to 5 quarters of bones per acre, at a cost of 18*s.* to 21*s.* per quarter; and by doing this they are able to manure a part of the meadow and pasture land. Guano is not much liked in this district. Turnip-hoeing is well attended to; and in November the larger roots are pulled and stored for the ewes in spring, and young stock in the straw-yards, and the remainder consumed on the land. The second year the land is ploughed and dressed for oats, and seeded down with white and red clover, trefoil rib-grass, common and sometimes Italian rye-grass. The oats are either mown or cut with a hook, called here a badging-hook; and when removed, the prepared lime and soil before alluded to is laid on the seeds. In some cases lime is put on alone, at the rate of from 50 to 60 one-horse loads per acre (12 pecks to a load). Lime is bought at the public sale kilns at 10*d.* to 1*s.* per load; but as slack is now readily obtained by the Peak Railway, the farmers prefer burning it themselves, which may be done at a cost of 8*d.* or 9*d.* per load. The seeds are pastured twelve or fourteen years, and the land again sown with oats. Very little wheat or barley is grown; oats are more profitable. On the old grass-land, where the herbage is coarse and sour, frequent dressings of lime are resorted to, which seldom fail bringing up the white clover, and improving the quantity and quality of the milk. Cheese is the great staple of the district, and many of the Derbyshire dairies are equal in production to those of Cheshire or Gloucestershire. Some persons use bones on the grass land; their effects are more lasting where cheese is made. The Duke of Devonshire and Thomas Bateman, Esq., have planted extensively. In exposed situations the ash, the elm, and larch become unsightly. The sycamore stands best for the outside of plantations, or for planting singly along the fences as shelter. The pair-horse plough, the drags, and harrows, are of the common kind, and carts are preferred to waggons in the hilly parts of the county. The farm-buildings are generally badly arranged, and unsuitable for improved husbandry; but considerable improvements are going forward on the Devonshire estates, under the agency of

Sydney Smithers, Esq. Very few of the buildings are spouted, and the rain-water is continually damaging the farm-yard manure. One reason why they are not spouted may be—they are covered with thatch without slates at the eaves."

The Sheep on these upland farms are generally of the Leicester blood. Their wool is not of that fine staple and quality found in the south. Nature has prepared the coat to the climate, by making it longer and coarser, and more hairy in the staple to resist the rains. Sheep-sheds are much wanted: it will be of no use introducing a finer-woolled animal without houses for them to shelter in. Where the sheep have been accustomed to sheds they house themselves, and frequently are seen anticipating the storm by making their way to shelter.

5. *The Clays and Gravels of the New Marl and New Red Sandstone, with the Alluvium of the Valleys of the Trent and Dove.*—This portion of the county is a highly-favoured region. It is, agriculturally speaking, "the Eden" of Derbyshire, a "land of wheat and of barley." The alluvium soils and detritus of the rivers are subject to natural irrigations, and the streams bring down by their overflow the essence of fertility from the mountain lime, the shales, and higher lands. The subjoined analysis by Mr. Haywood of soil taken from a field at Marston-on-Dove, in the occupation of Mr. Heacock, gives the following:—

Alluvium soil from the Dove Meadows. Mechanical analysis:—

Coarse silicious sand	15·860
Fine soil	58·170
Impalpable slay	19·170
Organic matter in a state of decay	6·800
	100·000

100 parts contain, in a chemical analysis:—

Organic matter, as stated above, containing a little nitrogen	6·800
Water	9·700
Silicates, containing ·640 of potash, and ·180 soda	71·300
Alumina—Oxide of iron and manganese	11·130
Carbonate of lime and magnesia	·840
Phosphoric acid (combined)	·131
Sulphuric acid (do.)	·005
Chlorine	·004
Soluble potash and soda	·004
Soluble silica	·006
Loss	·080
	100·000

Note by Mr Haywood.—"This soil contains all the elements necessary for the growth of plants, and would be benefited by ammoniacal tillages alone."

Analysis of alluvial subsoil from the above :—

Organic matter, containing a trace of nitrogen in a decomposing state	4·200
Water	9·600
Silicates, containing ·720 of potash and ·240 of soda	73·200
Alumina—Oxide of iron and manganese	12·300
Carbonate of lime and magnesia	·400
Phosphoric acid (combined)	·095
Soluble potash and soda (do.)	·005
Soluble potash and soda	·005
Soluble silica	·006
Chlorine (combined)	·003
Loss	·186
	100·000

Note by Mr. Haywood.—" This soil is similar to the surface soil, and capable of producing any crop."

The valley of the Dove, from which these soils were taken, is from half a mile to two miles wide, the adjoining heights being composed of red marl. In the meadows no drainage can be effected except that of open sluices, which carries away the retiring flood. The land is chiefly on grass, but it is rich in cereals and roots. The cropping is—

1st Year.—Fallow wheat.
2nd do. Oats.
3rd do. Fallow for turnips.
4th do. Barley.
5th do. Seeds—mown.
6th do. Wheat.

A great quantity of cheese is made in the valley, besides its production of beef and mutton. No lime is required, nor any kind of tillages ; and should the arable land show any symptom of exhaustion, plough deep and deeper still is the way of restoring its fertility. Like an exhausting fire, it only requires stirring up to make it again active. From 70 to 90 and 100 cows are employed cheese-making on the farms, and many calves are reared ; the first month they have new milk, afterwards linseed compound with skim-milk. The stock reared on the farms and naturalized to the soil are better grazers, better milkers, and more healthy than those which are purchased, and the butchers prefer them for slaughter, and frequently ask the question, " Was this beast bred at home ?" The farmsteads on this portion of the Devonshire estates are very good, comfortable, and convenient places for stock.

On the clays and gravels above the rivers Trent and Derwent the land is more arable, and easily converted into tillage, producing all the agricultural roots and cereals in abundance, and

of the finest quality. The meadows subject to periodical inundations supply hay, and consequently manure, to the higher lands. No tillages, with the exception of lime, are purchased; but the grains from the Burton breweries are bought largely by all the farmers within the reach of 10 or 12 miles. Contracts are entered into with the brewers to take quantities of from 2000 to 4000 bushels annually. The brewing-season at Burton extends over seven months in the year, beginning in the autumn, and continuing through the winter; during which time, it is estimated that 8000 quarters of malt are mashed weekly. These grains are equally divided, or nearly so, between the farmers of Staffordshire and Derbyshire, and, at 3*d.* or 4*d.* per bushel, are cheap provender for pigs and cows. Many farmers provide pits or tanks to store the grains, at a time of year when they are most plentiful. This practice has very much reduced the growth of hay. More cows are kept, and more land under pasture. The grains are pressed down in the pits, and will in this state keep sweet a long time. Pigs get the mouldy ones, and the dairy cows eat the other, mixed up with chopped straw and inferior kinds of hay.* The use of grains, in the economy of a farm, is of immense advantage. Much coarse and unpalatable food is consumed, waste prevented, and valuable manure made.

Salt is extensively used, in this part of the county, as a top-dressing to wheat and barley; it increases the quantity of corn, stiffens the straw, and prevents it falling down. It is applied at the rate of 7 to 10 cwts. per acre, at a cost of the same amount in shillings. In the neighbourhood of Chellaston, where the gypsum is used for the repair of roads, the scrapings are spread on the fallows to prevent clover sickness with good effect.

The disease which prevailed amongst the cattle a few years ago was of a serious nature, and many farmers sustained great losses. After the Mutual Cattle Assurance Association was established, insurances were effected at a low premium: this, with the epidemic, was the means of ruining what might have been a useful institution.†

The cropping on the red marls, taking the district of Weston-on-Trent, Melbourne, and the adjacent districts, may be placed as follows:—

1st Year.—Fallow for turnips, cabbages, mangold.
2nd do. Barley.
3rd do. Seeds, mixed with Italian or common rye-grass.
4th do. Wheat.

* Those farmers who have been in the habit of using grains are anxious for malt-tax repeal. They agree, if the malt-tax were repealed, they could increase the dairy cows, and reduce the growth of hay.

† "The ordinary weight of a cow's lungs in a state of health, will be from 14 lbs. to 20 lbs. The lungs of a cow that died of the epidemic weighed 97 lbs."

It is now a more common practice to allow the seeds to *lie down* two years, to throw the clover crops to a greater distance, and is considered a means of securing the clover. Autumn-dressing the stubbles is always aimed at, whenever the weather or time will allow. Skim-ploughs and scufflers are employed for these purposes, and the surface well pulverized. The weeds are either burnt, or, if dead and not bulky, they are ploughed down at the winter ploughing, and the land is soon prepared for turnips in the spring. On the stiffer loams mangold is a great favourite, and the cabbage grows to a large size. The largest plant of mangold, shown at the Melbourne exhibition, was 32lbs. with the top; the heaviest cabbage 46lbs.

Experiment with Flax.—A communication from Mr. John J. Briggs :—

"I sowed the linseed April 3, 1850, in drills 6 inches apart: the ground rich and good: space 10 square yards. Pulled up the plants September 8th, dried them against a wall for about a fortnight, and thrashed out the seed. Besides the fibre, which was excellent, I had 2 quarts of good seed. At the same rate an acre would produce 30 bushels, worth, at the present price, 9*l.* 15*s.* per acre. The ground was hoed and kept clean. Linnets and small birds are great enemies to the seed, and if sown in the field would take a great part of it. The seed was shown at the Melbourne vegetable show, and pronounced very good and fine. Several patches have been shown in this parish for experiment, but the idea of cultivating flax as a field crop is abandoned."

About 240 acres of land in Melbourne is under spade cultivation, and is employed in growing vegetables for the Derby markets or sent into the potteries for sale. The labourers are well employed at good wages, and have generally garden allotments near their dwellings.

The whole of *Appletree* hundred is good land for every agricultural purpose. Its name implies its fruitfulness. Near Derby the gravels are of a lighter character; the northern parts of the hundred, extending from Derby to Ashbourne, are of this kind. The cropping is very much the same as that practised on the dry turnip-soils, and may be placed as follows :—

1st Year—Fallow, mangolds, swedes, and cabbages.
2nd do. Wheat and barley.
3rd do. White clover and rye-grass.
4th do. Wheat.
5th do. Roots, &c.
6th do. Barley or oats.
7th do. Red clover.
8th do. Wheat.

The farm on which this course is followed is in high cultivation, and under the active management of Mr. Bryer. The turnips are grown on ridge with farm-yard manure and superphosphate from Messrs. Butel, of Derby, and large quantities of Burton grains find their way to Vicar Wood. It would be well

if this active management were followed. Travelling north-west towards Ashbourne, there is some indifference and carelessness: some practices which ought to be exploded, some fine land neglected, hedges in a wretched state, a sad deficiency of root-crops, and very few sheep, and little barley grown on the farms. Root-crops are, without doubt, extending in the south as well as the north, but there are some parts of the county where no efforts are made to accomplish this, and the district above referred to may be pointed out as failing in these praiseworthy efforts.

Draining on the red marls is going forward: the practice, as usually recommended by the Loan Commissioners for Drainage, has not been successful. On the old grass-lands the draining twenty years ago was the sod and turf or wedge draining, till the fortunate discovery of the tile-machine. No implement has yet been discovered so useful to the cultivator of heavy lands as the tile-machine. What the steam-engine is to the manufacturer the tile-machine is to the farmer. By its means many thousands of sheep are grazing in security and soundness, and the natural fertility of the land increased. From 3 to 4 feet deep, 6 or 7 yards wide, and a 2½-inch pipe laid down with exactness, is the common mode of draining the marls. The price of accomplishing this is much the same in the south as that given for the north. Labour is cheaper, but coals are dearer.

Sheep are of various breeds; the Leicester prevailing, occasionally mixed with the Shropshire Down and the Lincoln.

The implements are of the common kind; the ploughs are the ordinary sort, made in the neighbourhood, both single and double.

Improvements made since the Report of John Farey, senr., in 1815, *and to what extent still required.*

The improvements required are a continuation of those in progress, which are not few or far between.—The foregoing remarks on the agriculture of Derbyshire will have anticipated much that might be written on this head. In the voluminous remarks of Mr. Farey, it does not appear in his Report of Derbyshire Farming to what extent under-draining had been effected. Elkington had been extensively employed as a professional drainer in the northern counties with varied success, but it does not appear that he was equally successful in the conglomerated strata of Derbyshire. Elkington's practice failed, and the Deanstone, though successful in some degree, did not accomplish all that was promised by those who had adopted it in the north. One thing is most certain in the drainage of Derbyshire—that it is impossible to follow any general plan or rule. Experience can only determine the width or the depth, and it is better to err on the safe side. The dry seasons of the last few years, good trade,

emigration, and the high rate of labour, and the deficiency of hands, have checked the progress of draining; but it is patiently and quietly going forwards, guided by practice and experience. The great quantity of rain falling in the north and north-western parts of the county, as compared with that falling in the south or the eastern coasts of England, renders the necessity of drainage imperative. At Derby, the quantity of rain falling on the average is about 28 inches; at Chatsworth it has been averaged at 34 inches; Hathersage at 40 inches: and at Kinderscout, near Chapel-en-la-Frith, at 80 inches. In London the average of rain falling is about 28 inches, and at Harwich 23 inches. The quantity of rain falling, then, in any particular locality, has or should have an influence on the drainage.

I had fully intended a visit to all the tile-yards in the county, and from inquiry to have ascertained the quantity made at each yard during the year, and deduced the amount of drainage going forwards. The continued rains of the winter of 1852-3 reduced the amount of time given, and it became impossible.

The different kinds of oats, which have lately been introduced, of an early kind, combined with early sowing, have hastened the northern harvest, and this has further been pushed forward by an improved condition of the land. It may be asked, Would rye grow on the upland farms? If so, *it would yield more straw than any kind of crop that could be sown*, and it would be no less valuable, commercially speaking, than oats. Rye will grow on the sandy deserts of Sherwood, but its growth does not appear to have been attempted on the high districts of Derbyshire.

The farm-buildings are improved and improving, the difficulty often presenting itself, whether to pull the whole down and build new, or patch and repair the old. Many years of indifference and neglect to farm-buildings have allowed them to go out of repair; and it may be regretted that agricultural architecture has made so little progress. In all buildings of a useful rather than ornamental nature, such as workshops and factories, some uniformity of plan or design is carried out that is found by experience to be the most convenient and useful for the purposes intended; but it is not so in farm-buildings, every farmstead having a different plan or design. Where uniformity might prevail there is none. One cheap and useful design might be applied generally; but the difficulty is in fixing the new with the old, so as not to prevent future improvements. This applies not to any particular soil or district, but the whole county generally requires an improvement in this important branch of rural affairs. *If there be one neglect in Derbyshire more diffused and general than another, it is the too common want of spoutings to carry away the eaves-water from the manure. This has been before alluded to, and the evils of washing and brewing manures pointed out.*

There are many liquid-manure tanks in the county, but none making; and complaints and disappointments are common as to their usefulness. The presence of tanks has, in some instances, prevented the spouting of buildings. "It does not matter," said a farmer, "all goes into the tank;" forgetting the continued dilution of the tank-water increased the labour attending it, and damaged its usefulness. The great expenses which have attended the construction of tanks, the pump, the water-cart, prevent many farmers from giving them up altogether, and employing them for other purposes: "they will try a bit longer." On some farms the buildings have been spouted, and the tank converted into a rain-water cistern. In South Derbyshire, near to Burton, it is "suspected" they will presently be converted into grain-pits. The most effectual way of making and preserving manures, simple and inexpensive, will be found at the Long Course Farm, near Chesterfield, before noticed under the coal-series.

With the progress now making in farm-buildings should be a continued progress in the construction of well-sheltered sheep-sheds. The experiments of Mr. Cavendish show the advantages of protecting sheep from the rains and the cold; and the generally-expressed opinion of farmers of their great utility are so many proofs how much these additions to the farm-steads are required in the high districts.

Derbyshire *has been* famous for its breed of horses, particularly for the road. Before the enclosures the colts were turned out on the open commons, and not taken to work so early as at the present time. This breed of horses was in a great degree maintained by the liberality of the Duke of Devonshire, who kept at Chatsworth one stud of stallions of known excellence, who for a nominal price served the mares of his tenants and the neighbouring gentlemen. Derbyshire horse-breeders, having such advantages, were particular in the choice of mares; while the stud-groom exercised an active surveillance on the *make*, *shape*, and *qualifications* of the mares to do justice to the blood of Old Warwick, Raven, Aaron, Woeful, Pilgrim; and a better selection of mares is again wanted. It would be well if some brand or shame could be fixed on the many mongrels put to horse to produce valueless and unsaleable things like their dams, as certainly as "like produces like."

It is a question of the highest importance to the owners and occupiers of upland farms and estates how far judicious and extensive plantations would improve the climate and increase the temperature. And there is another question: Would plantations pay? The latter cannot safely be answered. It is premature to anticipate the price of the oak when planting the sapling; and it is impossible to offer any opinion what new wants or new de-

mands may spring up by the progress of human events. The physical doctrine of mutual protection is fully borne out in the vegetable world; and the healthy state of a plantation is materially influenced by its extent. The oak is stunted and worthless in the hedge-row; but the oak flourishes on the same kind of land when surrounded by other oaks and trees, nursing and protecting each other. The same with the larch and spruce, and nearly all resinous trees: they never do well when detached. The sycamore appears the safest, if not the only tree, to flourish on the exposed and barren hills; and it has been recommended to plant a belt of sycamore round plantations of larch and spruce. Professor David Low, of the University of Edinburgh, author of a valuable book on landed property, says, "The Cembra pine inhabits the highest Alps of Switzerland and other mountains in Central Europe, and those in Northern Asia. It is hardy, but like the Scotch fir has never been a favourite with the planter." Having put a few questions to that gentleman as to the kind of pines best adapted for planting the wastes of Derbyshire, I have received the following reply:—

"The wild pine, pinus sylvestris (Scotch fir), is suited to grow on the millstone-grit, and is the safest of the coniferæ to be planted on this class of soils. There may be something in the soil of Derbyshire unsuited to the Norway spruce, for in other situations, at least as much exposed to winds, &c., the accident to which you refer does not occur; the cases referred to by you may be accidental, and, notwithstanding, I would recommend you to have mixture of spruces with other coniferous trees. With respect to the larch, you are quite right in proposing it for the drier lands of the mountain limestone; and where the larch will grow you may safely depend on growing the pinus cembra. I am sorry to say, in respect to the larch, that in Scotland great losses have been sustained by the attacks of disease at certain periods of its growth. The extension of plantations is certainly calculated to improve any local climate by means of shelter; but unless the plantations are very extensive the shelter could scarcely be expected to extend beyond the locality of the estate or farm. It is known that the cutting down of great natural forests has in certain cases materially affected the supplies of water; but I cannot suppose any sensible effect would be produced by the limited artificial plantations which proprietors could form in any given district."

The usefulness of plantations is admitted on the upland farms, and occupiers are looking forward to the time when a thriving plantation will afford shelter to his homestead, and protect his stock from north-western blasts. The continued crusade going forwards against hedge-row timber renders it imperative some restoration should be made, lest the country be disrobed of its sylvan beauties, and entirely dependent on foreign supplies for domestic use. The extensive plantations which have already been made on the estates of the Dukes of Devonshire and Rutland, and at Stanton, Hopton, Middleton, have, without any doubt, improved the climate, and contributed in some degree (combined with other causes) to hasten the time of harvest in the upland

districts. Nothing would be more interesting, in an agricultural point of view, than self-registering thermometers placed in immediate proximity to plantations, or within range of their influence, and compared with others in exposed and similar altitudes. This would be a valuable test, and sufficiently show the advantage of giving shelter, and explain the secret of growing wheat at the elevation of Stanton-house. But then comes the question—would it pay? and what kind of trees would best flourish on Derbyshire mountains? 150 years ago the larch was a stranger, and treated as an exotic, and confined to a glass-house; and it is probable that many foreign trees of the pine tribe, now luxuriating in the wilds of Canada, or the snowy heights of Kamtschatka, or the Himalaya, would flourish in the moorland waste or the rocky precipices of the mountain-lime and the millstone-grit. Sufficient at present is not known of these plants to give a definite opinion as to their usefulness on English soil; but the inquiry is going forward, and will, without doubt, result in the importation of many useful forest plants from northern wilds. In accordance with these views I have the high authority of Sir Joseph Paxton, who, in reply to my inquiry, states, "the red pine (Pinus resinosa) produces the yellow deal of Canada, and would, without doubt, grow well in the highest situations, but it has not been tried extensively." With respect to the forest trees of the Himalaya, Sir Joseph says, "some would possibly flourish in Derbyshire; although the weather is cold in their native habitats, the great amount of sunlight elaborates their juices and perfects their wood, so that any amount of cold can be endured without injury. The Cembra pine would grow in the most exposed places; its wood is not equal to many others. Riga deals are made of a great variety of pines, and the common Scotch fir (Pinus sylvestris rigensis)." Nothing but a judicious examination of the soil and subsoil, guided by experience, could determine the kind of British trees best adapted for particular soils or situations. All the trees will flourish in the lower valleys: in South Derbyshire there are magnificent specimens of the oak, the elm, and sycamore; but the land is too valuable to grow timber except for ornamental purposes.

To all those gentlemen and friends who have kindly aided me in preparing a Report of the Farming of Derbyshire, I offer my best thanks; and, whether successful or otherwise, I shall not regret the attempt, having obtained much valuable information by the inquiry, and many valued friends and acquaintance, although continued rains and snow-storms prevented my visiting some interesting parts of the county, and doing that justice to the merits of "Derbyshire Farming" which it deserves.

IV.—*A Method of Preserving Corn-Stacks from Damage by Rooks.* By the Rev. Thomas Burroughes.

It is a general practice in this part of the country to disperse the corn-stacks about the fields, more particularly since the prevalence of incendiarism; and it is doubtless most advantageous, both on account of the expedition during harvest, and also on account of a greater degree of dryness thus derived to the grain than can be the case in a confined stackyard. But, on the other hand, a new disadvantage is thus incurred: the thatch is extremely liable to be injured by *rooks*, more particularly in severe weather, and no little amount of damage will often follow from wet; the rooks also continually pull out large quantities of grain from the sides and from under the eaves of the stacks. The usual protection against the mischief is a little boy, who is very often employed to guard a *single* stack, though sometimes several, if near together; and where two or more boys are required, as is often the case, for this purpose for many months together, the expense becomes considerable; and from their frequent neglect—for "Quis custodiet ipsos custodes?"—there is, after all, very often much damage done.

I have, therefore, been led to adopt, for the last few years, a very simple, but certainly effectual plan, and which I see has now become extensively imitated: hazel twigs, about four or five feet long, are stuck round the stack, pointing at an angle upwards, and at a distance of about four yards apart; one row a little below the eaves of the stack, and another about halfway up the thatch, the upper twigs being placed in an intermediate position between the lower; lines of worsted or strong cotton are then suspended from a small stick on the top of the stack to the ends of these twigs, and cross-lines also between the two rows, as well as lines along each row: the whole thus forming a sort of loose *net-work;* and at the cost of only 1*s.* two or three stacks may be thus fully protected. The net-work will last a full year, if required so long, though parts of it may occasionally require repair, as after very high winds; and perhaps there can be no greater proof of the efficacy of the plan, than the fact, that if any part of the worsted has been much broken away, an attack after a short time is sure to be commenced on that part of the stack.

Gazeley, near Newmarket,
February 26, 1853.

V.—*On the Production of Butter.* By Louis H. Ruegg.

It is related of a celebrated sculptor, that, when reproached by a friend for having made no progress in his work, he pointed to the statue, and said, "You mistake: I have been by no means idle since you were here. I have retouched this part and polished that; I have softened this feature and brought out that muscle; I have given expression to that lip and more energy to this limb." "Well, well," rejoined his friend; "these are but *trifles*." "Very true," replied the sculptor, "but trifles make *perfection*, and perfection is no trifle!"

This, which is a truth for all time—for every man, under every circumstance of life—is to no occupation more applicable than to that of farming generally, and to no particular branch of farming more valuable than to the business of which we have now to write. The production of butter is an operation that is conducted in much the same manner, whether it be performed in Holland or in Ireland, in Dorsetshire or in Cambridgeshire, and yet a difference in value of full 20 per cent. is often struck in the London market between the produce of contiguous dairies! What constitutes this difference? Not breed—not soil—nor food alone (though all these have their influences); but those minute attentions which in themselves are but trifles, but which accumulate into perfection.

Butter-making is a process conducted in pretty much the same manner in every county, and an account of the operation, as it is performed in Dorsetshire (whose butter holds the highest rank in the quotations of the London market), may serve for a general description. The cows are milked twice a day—in summer in the fields, in winter generally in the straw barton. The milk is purified by being passed through a sieve, and then set to cool in milk leads. In some counties glass-ware or stone coolers are used; but a Dorsetshire farmer will use nothing but *leads*, which he finds the cleanest, sweetest, and in every respect the best of milk-coolers. In these the milk is allowed to stand for a period varying from 12 to 36 hours, according to the season, the quantity of milk at command, &c. Usually, after standing for 24 hours it is skimmed, and the cream is collected in tin vessels until sufficient to form a "churning" has accumulated. In very large dairies and in the summer season butter is made every day; and it may be laid down as a general rule that the quicker cream is converted into butter, the sweeter and better the butter. It should not be allowed to remain longer than three days under any circumstances. The churn having been prepared by rinsing, with hot water in winter and with cold water in summer, the cream is agitated until a complete separation of the fatty matter from the

milky fluid has been effected. This operation is a most uncertain one; its duration varying from 10 minutes to 12 and even 24 hours, according to the temperature, the quality of the cream, the state of the weather, the operation of the churn, and other circumstances. The butter having "come" (to use the language of the dairymaid), the whey is drawn off for the pigs, and the butter is taken out and well washed. It is then worked with the hand until the buttermilk is thoroughly expressed and the air-bubbles are broken. A portion of salt is mixed with about each half-dozen pounds; the manipulation is resumed; the lump undergoes a second washing, which carries off the surplus salt; and it is finally made up into rolls or printed pats for the home-market, or, with an additional salting, is packed in clean tubs for the London factor.

In Bucks milk is skimmed at the end of 12 hours, and this process is repeated at the end of 24 and 36 hours; and during the winter it is subjected to the skimmer a fourth and even a fifth time. In Devonshire, where much clouted cream is made, it has been attempted to increase the proportion of butter from cream by scalding the milk; but on this point Mr. Acland, in his Report on Somersetshire, furnishes some conclusive facts. Mr. Acland had 12 quarts of raw milk tested against as many of scalded milk, and it was found that not only was there loss by evaporation (as might have been expected), but that the quantity of cream and the weight of butter were less from the scalded than from the raw milk; and an analysis by Professor Way shows that the largest proportion of pure butter was found in the latter.

The primal condition of excellence in butter-making is *purity*. Milk is in the highest degree susceptible of taint. Milk in the udder may be poisoned by the cow eating improper food. "Milk," says Dr. Taylor, in his work on Poisons, "is rendered bitter when the cow feeds on wormwood, on sow-thistle, and the leaves of the artichoke. Its taste is affected by the cabbage, the carrot, and all strong-smelling plants, and the effects extend to butter and cheese, and all articles of food prepared with milk." Milk may even be poisoned without the cow being affected, in proof of which the same writer refers to the case of some inhabitants of a district in North America, where a disease called the cow-sickness, symptoms of having been poisoned, and even death itself, were caused by the milk of cows fed on unwholesome herbage. With so sensitive a fluid, therefore, the utmost care is required, not simply as regards the milk itself, but also the food which the cow eats and drinks. Cows are sometimes permitted to drink from a barton-pond, which the drainings of liquid manure had made, to use a common expression, "as black as a hat." Others, again, are allowed to slake their thirst in the waters of stagnated ditches, or in ponds which have been slowly decomposing animal or

vegetable refuse matter. If milk is so liable to be affected that it may be the medium of conveying poison through the cow, it follows that the quality of butter very materially depends upon the quality of the water which the cow drinks.

The necessity of *cleanliness on the part of the dairymaid* is insisted on by every writer on this subject. The dairy-vessels must be scrupulously clean: they and the dairy itself must be removed from everything that taints the air. The fumes of a stable, or the effluvia of a pigsty or dungheap (which are too frequently found in the vicinity of the dairy-house), injuriously affect the butter. If the cooler be made of zinc, a very serious effect indeed may be produced. "It is probable," says Dr. Taylor, "that some of the lactate of zinc is here formed, as well as a combination of the oxide of iron with casein. I have been informed that milk and cream which were allowed to stand in such vessels have given rise to nausea and vomiting. This practice would not be allowed under a proper system of police." Even when the cream is safely "boxed," it is not out of danger: for in the box-churn the whey often escapes through the spindle-hole, and the butter gets a metallic taint. In its next stage, if the hand of the dairymaid be moist or "sweaty," or recently washed with soap, the butter acquires a rancid taste; and though it may have reached the tub in safety, it frequently spoils from improper packing. In fine, from the time when its elements are first formed from the succulent grass of the field until the time when it appears on the breakfast-table, butter leads (so to speak) a most precarious existence, and its preservation depends almost entirely on the *trifling*, but constant, attentions which I have endeavoured to indicate.

The Cow.—The quality of butter and the quantity of milk depend less on the breed than on the *food* of the animal. It is almost impossible to assign to any particular *breed* the milching palm—it belongs to the *individual* animal. I have found one dairyman speaking of Herefords as the best milchers within his experience; his neighbour favoured the beautifully symmetrical North Devon; whilst a third declared that the best milk-producer was a cross. In the London dairies the Yorkshire short-horn or the Holderness cow is almost universally found. A London dairyman told me that the red cows were regarded with antipathy by almost every cowkeeper in the metropolis. He could not account for it, but the dappled cow always had the call in Smithfield. It is, however, not difficult to discover that the cow selected is of a breed that generally gives the largest quantity of milk without reference to the quality, as, by the London dairyman, milk, and not butter and cheese, is the article required. The Hereford, the Devon, the short-horn, and the cross are good,

according to their *individual* capacities. A cow is considered a good milcher if she yields six quarts at a milking when in full milk, but the quantity of milk varies in every individual cow, owing to an infinite variety of circumstances quite beyond the power or the skill of man to anticipate.

Mr. N. Le Beir, honorary secretary of the Royal Agricultural Society of Guernsey, has obligingly furnished me with some particulars respecting the Guernsey cow, which may be introduced in this place :—

The Guernsey Cow.—" The Guernsey cow," says Mr. Le Beir, " is small, a good deal in appearance like the Brittany, but very much superior in quality. The produce in two cases is thus publicly stated in the Agricultural Reports of the island. Sir William Collings names a young cow that gave from the 14th July, 1843 (time of her first calving), to the same date in 1845, 716 lbs. (Guernsey) of butter, about equal to 800 lbs. English, of a rich yellow quality. Thomas Priaulx, Esq., also gives the following return of one year's produce from 1st January, 1847, to the 31st December, of five cows kept and accounted for by his farmer, on the *metayer* or half-and-half principle :—

" Butter, 1340 lbs. (Guernsey), average 1*s.* 3½*d.* per lb.	£86	10	10
Milk sold	4	3	3
One fat bull-calf	2	8	10
Four heifer-calves, valued 15*s.* each	3	0	0
Buttermilk, valued ¼*d.* a quart	11	3	0
	£107	5	11

" Each cow thus producing 21*l.* 9*s.* 2*d.* The farm is of sixteen acres.

" The average produce of the island is not of course so high ; it is estimated at about 200 lbs. a year for each cow ; only the good ones are kept, the inferior being at once fattened.

" The manner of feeding is as follows :—The cows are tethered in the fields with about a twelve-feet rope all the year round, but housed at night in winter and on very rough days. They are milked three times a-day in summer, and the peg changed five times, in fine clover about two feet each time ; in winter, except a short time after calving, they are milked only twice : in that season they have roots constantly given. The cream is yellow and very rich : in some cases about seven quarts of milk will produce a pound of butter. Cows have sometimes given twenty-four quarts of milk a-day, but then it is not so rich : eighteen quarts is considered very good. The whole milk and cream is churned. In England they are hardly estimated to their real value ; their small size, on account of the meat, being objected to. Besides, they never bear flesh like the English cow ; what food this turns into meat, the Guernsey cow turns into butter. It is not much known that a good milcher is often kept from fifteen to eighteen years, and on that account, as well as consuming less food, must be a desirable acquisition to the English gentleman and to the dairyman.

" N.B. 102 lbs. Guernsey weight is equal to 112 lbs. English.

" N. Le Beir, Hon. Sec., R.A.S.G.

" *Guernsey*, 22*nd February*, 1851."

The *Food* most likely to produce an abundance of milk must specially occupy attention. Dorsetshire is favourably situated as a butter-producing county. Its pastures are sweet, and the great quantity of moisture impregnated with salt which the

winds, passing over both Channels, bear over the county, promotes the growth of herbage. A Dorset dairy-farmer will tell you that there is nothing like good sweet grass for the production of a large quantity of milk fit to make the very best quality of butter, and that during the winter the best food for cows is the hay made from the best sort of grasses. Doubtless good natural grasses are the most economical and best summer food of cows, as is the hay for the winter, but the great object of our search is the best substitute or auxiliary. It cannot fail to have been remarked, that one pasture is admirably suited to the making of cheese, and is comparatively worthless for making butter, and *vice versâ*. The solution of this difficulty cannot be obtained until scientific research has enabled the farmer to ascertain which of the natural grasses is best suited for cheese and which for butter. The London dairyman, on the contrary, insists on the milk-producing properties of distillers' grains. Amongst both classes swedes are disliked, for the strong and disagreeable turnipy flavour they impart both to milk and butter; and even the very valuable discovery made some few years since by the Rev. Anthony Huxtable, of Sutton Waldron, though proved to be a complete remedy for the evil, has failed to introduce the general use of swedes into the Dorsetshire or the London dairies. This remedy is so important, that, though it has appeared several times in print, I am induced to insert it in this paper. The recipe was kindly given to me by the reverend gentleman himself:—

"Dissolve half an ounce of chloride of lime in one gallon of water, and add a table-spoonful of this to each gallon of milk. Frequently, if the turnips are very strong, *three* times as much will be required; but this will depend on the dairywoman's taste."

The practice of root-feeding dairy cows, however, is a growing one, and from many quarters we hear of the cheapness, to say nothing of the *convenience*, of this system of feeding. When the pastures are locked up in winter and hay is neither very good in quality nor cheap in price, the turnip-cutter is one of the dairyman's best friends. At a farm in Hampshire I found sliced turnips given the cows twice a day. A little saltpetre was put into the milk, and the taste of the butter was by no means disagreeable. In February (1851) it was realizing 13*d*. a pound in the Southampton market. A Somersetshire gentleman boils his turnips with chaff, and then mixes pea or bean meal with the mess. He gets $6\frac{1}{4}$ lbs. of butter per week from each cow, without any taste of turnips.* A somewhat similar practice is detailed in a notice of Moresby Hall farm, near Whitehaven.† The cows receive turnips twice a day, two stones weight at each time.

* Agricultural Gazette. † The 'Times' newspaper.

They receive likewise a cooked mixture of oats and tares, grown together for that purpose, and cut by the chaff-cutter, then boiled with chaff, and given twice a day—a bucketful to each cow at a time. At Cunning-Park farm, Ayrshire, a notice of which has also appeared in print, " cut hay, crushed grain, mangold wurtzel, &c., are all boiled together" for the cows. In a report on the farming of Surrey, published in 'The Times' last year, it is stated that the produce of cows, partly fed on mangold and on brewers' grains, was disposed of to one of the first hotels in a fashionable watering-place at 1*s.* 4*d.* in winter and 1*s.* 2*d.* in summer. The Rev. A. Huxtable finds " green clover and tares, Italian rye-grass, swedes, mangold wurtzel, carrots, and the farinaceous substances—bran, oil-cake, and bean-meal—the most butter-producing substances for house-fed beasts. The fresh tops of swedes and of the mangold wurtzel are highly productive of milk, when given in moderate quantities in conjunction with dry food." The immense advantages to the dairy-farmer that may be derived from the growth of Italian rye-grass and clover, forced into rapid maturity by liquid manure, in conjunction with the moderate use of swedes when grass is short and hay dear, will be seen and admitted by every one who bestows a single thought upon the subject. By watering with liquid manure, Mr. Huxtable cuts his clover four times in a season, and is enabled to carry off a crop when, as he has emphatically expressed it, it is worth its weight in gold for the dairy—viz. in August. In the London dairies Italian rye-grass is much favoured, and the use of brewers' grains, in the proportion of a bushel a-day for each cow, with mangold, is universal.

Churning.—The production of butter by churning is both a chemical and mechanical process. Milk, according to the analysis of Henri and Chevallier, is composed as follows :—

Casein, pure curd	4·48
Butter	3·13
Milk sugar	4·77
Saline matter	0·60
Water	87·02
	100·00

By the mechanical operation of the churn the envelopes of the globules of fat are broken, and the globules brought into cohesion. By the chemical process the sugar of milk is converted into lactic acid, and the bulk of the fluid, which was put sweet into the churn, is instantly soured. The best temperature for obtaining these results has been found by experience to be 60° Fahrenheit. To attain this temperature the dairyman rinses his churn in summer with cold water, lest the butter come too quickly, and be flaccid and pale, and in winter with warm water, lest it come not

at all. The churn most in use and in favour is the old-fashioned *barrel*-churn, the dashers of which are *fixed.* The box-churn, with its revolving paddles, abstractedly considered, appears preferable to that in which the dasher is fixed; but it has been found almost impossible to prevent the escape of whey from the spindle-hole, and, far worse, a metallic taint from the same source. Further, an intelligent dairyman pointed out to me that in all the churns in which the cream was not turned round bodily there would be some corner untouched by the paddle, and that therefore the manufacture of butter must be to a certain extent incomplete. It is deemed a high recommendation by the makers of churns "to produce butter in ten minutes;" the old barrel-churn, properly warmed, however, will fetch it in cold weather in a quarter of an hour. But the dairyman does not grudge an hour, and would rather expend a little more time on the churning, and have his butter firm and of good colour, than have it turned out in ten minutes pale and frothy. Another objection urged against the metallic churn is the expense. Nearly all those exhibited at the Exeter Meeting of the Royal Agricultural Society were mere playthings in the estimation of the dairyman. The largest was computed to make only 28 lbs. of butter, and the price of it was 2*l.* The barrel-churn in use in Dorsetshire makes a firkin, and an excellent one made of oak is obtainable for 50*s.* The motive power varies according to the circumstances of each dairy. Generally the churn is turned by manual labour; but in Bucks, in the present day, butter is churned by horse-power and water-power; and this butter produces in the district of Aylesbury 1*s.* 2*d.* a pound. At the Cunning Park dairy farm (before referred to) there are two large churns driven by steam. "The apparatus is something like the fanners for blowing a furnace, placed in a trough considerably wider than the fanners. The flies of the fanners agitate the cream in the trough. From half an hour to an hour is occupied in churning." Churning is not now so precarious an operation as it was in the days of the upright plunge-churn; yet I heard a few days since of an unfortunate dairymaid who churned for *two days*, and was then obliged to consign the obstinate fluid to the pigs' trough! In this case the cows had calved many months before, the pasture was bad, and the weather unfavourable.

Letting Dairies.—The practice that obtains in Dorsetshire is as follows:—The farmer lets off his dairy from Candlemas to Candlemas, at a rent ranging at the present time from 8*l.* 10*s.* to 10*l.* per cow. An agreement is drawn up between the parties, in which the dairyman, joined by sureties, agrees to pay the rent, and the farmer undertakes to appropriate such and such fields (at the rate of from $2\frac{1}{2}$ to 3 acres per cow), partly for summer graz-

ing, partly for hay in the winter. The cows are to calve by Old Lady-day, and the heifers by the first of May, or an allowance of 5*s.* per week for each beast is to be made by the farmer. The barreners are to be given up by the 23rd of November, and on Old May-day the calves are to be taken by the farmer at a valuation, or at the price of a quarter's rent. A dwelling, dairy-house, and suitable premises are included in the rent. Although to this system of letting dairies I am inclined to attribute very much of the excellence of Dorset butter—the manufacturer having a direct interest in his commodity, and the strongest of all inducements to make the very best article—yet the practice is opposed to that mutual interest which has often been declared to be the mainstay of agriculture. The interests of the farmer and those of the dairyman are evidently antagonistic. It is the farmer's interest to keep his cattle as cheaply as possible, without regard to the quality or quantity of their produce. On the other hand, it is the dairyman's interest to get all the milk he can from a cow without reference to the cost of production.

We now come to the *Supply of Butter*.—The principal supply is from Ireland and from abroad, and more than half of the foreign consignments is from Holland.

The following return of foreign imports has been kindly furnished to me by the Board of Trade :—

"An Account of the Quantities of Butter imported into the United Kingdom in the year 1850; distinguishing the countries from which the same were imported.

	Cwts.
Russia	31
Sweden and Norway	7
Denmark	4,696
Prussia	3
Hanover	16,379
Oldenburg	20
Hanseatic towns	51,368
Holland	226,821
Belgium	18,478
Channel Islands (foreign produce)	158
France	638
Spain	4
Turkish dominions	1
British North America	5,250
United States of America	7,281
	331,135

"*Office of the Inspector-General of Imports and Exports, Custom-house, London,* 31*st Jan.*, 1851."

A comparison of this return with the "Statement of the quantities of the principal articles of foreign and colonial merchandize imported and retained for home consumption in the United King-

dom in the year 1849," shows that foreign imports of butter are increasing, especially in those countries from whence our largest supplies are derived. The following is the return of the imports of butter during 1849:—

	Cwts.
Russia, Northern Ports	32
Sweden	3
Denmark	9,535
Prussia	54
Mechlenburg-Schwerin	125
Hanover	6,909
Oldenberg and Kniphausen	3
Hanseatic towns	36,492
Holland	200,797
Belgium	21,524
Channel Islands (foreign goods)	32
France	252
Madeira	6
Gibraltar	2
Turkish dominions	2
Morocco	1
British Possessions in South Africa	1
British North America	3,341
United States of America	2,855
Total	281,969*

Equal in importance, as regards quantity, is Irish butter. The annexed returns have been furnished to me by a gentleman who represents one of the first provision-houses in London.

* Since these figures were in print I have been favoured with the following return of the imports of butter in the last year:—

"An Account of the Quantities of Butter imported into the United Kingdom in the Year 1852; distinguishing the Countries from which the same were imported.

	Cwts.
Russia, Northern Ports	13
Sweden	1
Norway	152
Denmark	4,285
Prussia	1
Mecklenburg-Schwerin	2
Hanover	1,175
Oldenburg and Kniphausen	1
Hanseatic Towns	48,323
Holland	211,801
Belgium	16,782
The Channel Islands	52
France	2,183
Egypt	1
British North America	450
United States of America	275
Total	285,497

"R. D. WOODIFIELD,
"*Inspector-General of Imports and Exports.*

"*Office of the Inspector-General of Imports and Exports,*
Custom-house, London, 26th February, 1853."

"Imports of *Irish* Butter into London and Liverpool during the last five years.

	Firkins.
Year ending April, 1846	344,634
" 1847	307,716
" 1848	382,718
" 1849	360,299
" 1850	380,758
Average	356,000
Average imports of five years from Ireland into Liverpool	380,000

"Irish butter for London is shipped from the following ports, and in about the proportions annexed:—

	Firkins.
Waterford	140,000
Cork	90,000
Limerick	70,000
Sligo	12,000
Dublin	13,000
Tralee, Wexford, Newry, and Galway	35,000
	360,000"

Bristol and Glasgow also import Irish butter; Cork exports large quantities to Lisbon, South America, West Indies, and colonies and ports in the English Channel.

It may appear somewhat strange that the Belgians can send us *fresh* butter from Ostend, whilst Irish butter reaches us as salt as ships' provisions. The explanation given of this is, that the Irish butter sent to these markets is not prepared for quick consumption, and is therefore salted for long keeping. Small shopkeepers prefer it, as a firkin will stand for weeks on their counters without injury, where English or Dutch would get rank from exposure to the air. Again, many of the Irish dairymen are very small makers of butter, and take a long time to fill a firkin. "The greatest drawback to Irish butter from Limerick, Cork, Tipperary, and Sligo, is," says the factor to whom I am indebted for the above statistics, "the strong taste and smell of peat and smoke it has. Many of the farmers have no dairies, and they set their cream in their cabins, which, in many instances, have no flues. Irish butter would rule much higher if it was not so salt, and was free from the odour of smoke. It has, however, this advantage: whilst Dutch and fresh English *must* be sold at the market price, whatever that may be, when it arrives (and at times the loss is great), Irish merchants can keep their stocks." The fresh butter in Ireland, properly made, is as good as any other butter, especially that made in the county of Cork, where the dairywomen took a lesson from the wives of the militiamen of Dorset, who in the early part of the war were quartered there. The Dutch butter

is a very superior article, and arrives in this country extremely well packed; but "there is no article in butter," says a London factor, "that is so great a favourite as Dorset butter, if supplied while *fresh*, and properly packed in air-tight boxes." This word, however, is the alpha of the London factor's complaints. Numerous and loud are the complaints from London factors against the casks of the west-country butter producers. The Friesland butter is sent over in oak casks—beautiful specimens of workmanship—perfectly air-tight, and weighing 20 lbs. a-piece, whilst home country butter, for the most part, makes its appearance in badly-made casks, weighing but 6 or 7 lbs. each. The Irish firkins, though not so well made as the Dutch casks, are considered better than those generally used in England. Fresh butter is sent in flats, in 2 lb.-rolls. The greatest quantity of fresh butter is received from Buckinghamshire, Oxfordshire, and Northamptonshire. It is a curious fact that Cambridge, which once had a name for butter in the London market, and was the leading English butter county 100 years ago, is, in that sense, now completely extinct, as far as the London factors are concerned: and so much has the course of things altered, that Dorset butter is now sometimes purchased in the London market for consumption in Cambridgeshire. Butter is produced in large quantities in Yorkshire and Cumberland; that of Yorkshire is principally consumed in its own locality; that of Cumberland finds its way very much into the eastern counties, in casks, the article being much suited to the trade of those parts. It is difficult to ascertain with accuracy the quantities of butter supplied to the London market by the home counties; but a well-informed factor estimates the produce of Dorsetshire at from 30,000 to 40,000 firkins per annum, and of Buckinghamshire and Oxford (which do not appear in the printed quotations) at the same weights each. The produce of Northampton is estimated at about half this quantity.

Now that the farmer's returns from cereal crops are not regarded as the paramount object of farming, the production of butter—as a part of the system of grass-farming, now so much in favour—assumes an especial importance. That which was formerly delegated to the dairymaid requires then, and deserves, the best attentions of the intelligent farmer, who will find his painstaking and skill in the production of this article rewarded by a ready demand at steady prices. The history of the butter trade, and the assurances of the most intelligent factors, confirm the opinion, that prices of butter will not fluctuate like those of corn, and that a market will always be found, and a preference given to the best productions of our own country.

VI.—*On the improved Methods of Cropping and Cultivating Light Land.* By Sydney Evershed, Albury, Guildford.

Prize Essay.

Agricultural science and practice, combined or separate—if they can be separate—both receive the same enlightened consideration from the Royal Agricultural Society of England. Within the last few years the whole system of British agriculture has passed under the review of many eminent scientific and practical men; and among other much-vexed questions the cropping of land or the rotation of crops has received its due share of attention. Chemical science has been brought to bear upon it; the labours of the geologist have not been wanting, and experiments have been tried throughout the length and breadth of the land, with a care and at an expense of time and money, fully proving that there are numerous competitors for the deathless honour of showing how two blades of grass can be made to grow where but one grew before. In fact, almost every nerve has been strained to increase the British farmer's powers of production; and these patriotic efforts have not been made in vain. Every intelligent farmer can recognise some improvement which has been lately worked out by the energies of science or practice, or by a combination of both.

Hitherto the main improvements have been introduced through the experience of practical men; but the labours of science have not been without their influence! and, to say the least, science has dignified practice by corroborating its experience. Practical farming bears date with the earliest history of mankind: experience soon grew out of practice; and they both speedily became what they have continued to be, inseparable allies; but their maxims and results, gradually developed, and more or less confirmed, have been chiefly handed down to us traditionally. Science was born at a later date; and however jealous each may have been of the importance of the other—however much they may have differed both in birth and education, and however difficult it still may be to consummate their happy union—it is now beyond a doubt that they must go hand in hand together.

This essay is written by a practical man: one who has not been insensible to the great advancement in the knowledge and dignity of the art of farming; and who is not inclined to disregard the suggestions of any monitor who promises to cast new light upon the scientific or practical reasons why plants grow and thrive better under some conditions than under others.

Scientific men invariably lay the results of their investigations before the public; practical men among farmers are not gene-

rally in the habit of doing anything of the kind. Scientific discoveries are no sooner completed than made known to the world, and become of immediate use, according to their merits. The discoveries and improvements of practical farmers are generally much longer in becoming known to those who need them. It is the perception of this which has chiefly induced the writer of this essay, though not rich in any new discovery, to send in some of the results of his own observation and actual experience, strictly confined to *practical* farming. Those who seek the aid of scientific research, for the purpose of applying it to the management of any soil or crop, may find it in the writings of such as have made the various branches of this science their peculiar and earnest study, and who have enriched the world by their discoveries.

The subject treated of in this essay, as having been more immediately under the observation of the writer, will be the courses of cropping upon the chalks, loams, and light sandy soils of Surrey and its immediate neighbourhood.

A few years back the well-known four-course system, commonly called the Norfolk system—wheat, turnips, barley, seeds—was all but universally in use on the soils spoken of. Lately, there have been many departures from this course, partly because landlords upon reletting their farms have found themselves less able, and perhaps less willing, to confine their tenants to one prescribed course, and partly because tenants have been in most cases willing to try whether, by more manure, land would not bear to be cropped more frequently with corn; in fact, farmers have become more or less experimentalists, and in many cases they have changed their course of cropping, as certain fluctuations in the price of their produce gave them reason to change their opinion with regard to the policy of growing more of this or less of that crop; feeding more stock, and therefore growing more roots; or, as is too frequently the case, curtailing the root-crop and planting a greater breadth of corn.

On light dry land, whether chalk or sand, bearing a rent of about 1*l.* per acre, the four-course is still the prevailing system; and many good farmers contend that more can be produced from a given quantity of land, such as is here alluded to, by this course than by any other. One most essential condition to its success, as to that of every other, is perfect cleanness. The old method of preserving this necessary cleanness, and one still much in use, is to allow the land to lie fallow once in four years, from the time the wheat-crop is harvested until the following May or June, when the root-crop is planted. During this interval of rest the weeds are destroyed by three, four, or even five ploughings, drag harrowings, small harrowings, and rollings, according

to the foulness of the land, and to the farmer's determination to clean it, at an expense of *3l.* to *5l.* per acre.

The turnips or swedes are planted in May, June, or July; manured with farm-yard manure, guano, bone-dust, and ashes, or, perhaps, by superphosphate. The root-crop is fed on the land by sheep. Barley is sown the next spring; seeds are sown in the barley; and the barley being harvested, the seeds remain, and are mown for hay, and fed by sheep during the following spring and summer; at the ensuing Michaelmas, farm-yard manure is again applied, and the land sown with wheat.

Such is an outline of the common four-course system. The first and most common deviation from this routine is to cover the fallow with a green crop, rye or tares, which prevents the fallowing, and produces a crop of green food, to be fed off by sheep, or ploughed in as manure for the root-crop. The only objection to this crop has been the doubt whether the land could be kept sufficiently clean. Another variation of the four-course is to omit planting seeds amongst the barley, and, instead of a crop of hay the following spring, to produce a crop of peas or winter beans; wheat following the pea or bean crop, instead of being planted upon a grass or clover ley.

It is also common to plant oats or wheat instead of barley; but this is merely adopted in cases of emergency, when a proper barley-season could not be prepared, and it cannot be called a distinct course, being planted for a change, or because it might be thought that one would bear a better relative price than another. The following course is sometimes met with, *i. e.*, wheat after turnips, seeds in the wheat; oats after seeds, and peas after oats; but though a plentiful supply of manure may enable the land to bear this rotation with tolerable success, the want of sufficient opportunity to keep the land clean has hitherto prevented it from being more extensively pursued.

A most signal departure from any old system of cropping, which has gained ground in a few instances, is the alternate growth of roots and wheat. Although this mode has long been known and practised on a small scale—as a distinct and adopted course—it is of very recent introduction. As there is generally a vein of more tenacious soil upon every light-land farm, a different rotation is pursued upon it; and as there is a difficulty in feeding off roots upon such land, they are generally omitted from the rotation, or carted off when grown; and beans, wheat, seeds, and oats are sown, either as here stated, or according to the judgment and wants of the occupier, care being taken not to infringe the covenant, which confines every course to two crops of white corn in every four years.

No doubt additions might be made to the courses here roughly

sketched, still it is believed that they embrace the most common methods of cropping as pursued by the last two or three generations of farmers; but within the last four or five years there has been an effort as energetic as it has been universal to stimulate land to increased production. The laws of cropping land were not so immutable as to escape a searching inquiry as to their fitness for the modern agricultural constitution.

Upon no description of land have these laws or customs been so completely revised, old ones abolished, and new ones established, as upon that land now under consideration. The obvious reason why attention has been so much directed to this more pliable land rather than to the heavier clay districts, is because lighter land is cultivated at less expense, and because upon one both stock and corn can be produced, and upon the other chiefly corn.

And now it may be justly asked, What are the modern improvements and alterations? If one of our forefathers, deeply imbued with all the known agricultural economy of his own imes, could sit in judgment upon the various changes lately ntroduced, what could we show? How could we prove that agricultural improvement had not departed with his generation? We could show much; we could explain the new-born aid of science, having yet accomplished something, and full of great promise for the future. We could show that what we call "drainage" has converted thousands of acres of miry, sedgy swamps into open, fertile uplands; and, after reviewing in succession our fine breeds of stock, our improvements in grubbing hedges and coppices and cutting timber, our use of artificial manures, the wonderful power of our machinery and its varied application, we may imagine this venerable ancestor would scarcely realise the idea that as yet we are but laying the foundations for a far more perfect system; but he would retire from the review as proud of his descendants, and probably as much struck with their works, as one of our existing wise men would be, could he review by anticipation the economies of generations to come.

What are the changes which have been introduced into our system of cropping within the last few years? In the first place, landlords and tenants have, in most cases, adopted more iberal covenants, which allow the tenant greater control over his course of cropping. This was absolutely necessary to improvement, unless it was thought that the old covenants and courses of our ancestors were infallible. Fortunately this is not generally the case, and, where landlords still refuse to open their gates to improvement, they must be content to have their land tenanted by men who are in every way behind the age in

which they live, and who will not wield that capital and energy so necessary to unfold the resources and bring forth the real value of the land intrusted to their keeping, Still there is every reason to hope that this first step towards improvement will be universal: it must be a work of time; but it is already so general and so happy in its results as to justify this conclusion. The greatest change in the management of the four-course system which strikes those who have for some years criticised our agriculture is the diminution of clear fallow. How is this? Cleanness is one of the first requisites in good farming. Are we to break the back of any new system, or of a wise deviation from old customs, by being overgrown with weeds and rubbish? We shall, unless we are very careful, and most fully persuaded that if a weed is allowed an inch it will soon take an ell, and that those little weeds which creep at our feet demand the full exercise of our sagacity to prevent their rising into a fatal importance. In the first place, if land is foul, it must be made clean, and that by clear fallowing: there is no escaping the matter—no pains must be spared, and it is of little avail to half-fallow in such a case. *First get the land thoroughly clean, and then keep a vigilant eye upon it to insure its being kept so.* The writer is well acquainted with a few perfectly-clean farms; and a practice is observed on such farms, simple in itself, but of inestimable value. Immediately after harvest, every stubble not planted with grass-seeds is looked over carefully by men, women, and boys, to spud up every piece of couch, crowsfoot, or any other weed, which could not be destroyed by being buried by the plough. This is generally done as daywork, but it can easily be let at so much per acre. Upon land subjected, at every opportunity, to this treatment, the cost of spudding the stubbles varies from 6*d.* to 8*s.* or 10*s.* per acre. It is, I believe, universally admitted that couch-grass can be more completely eradicated by the spud than by either the harrow or the scarafier; and after this process all the trifling annuals are destroyed by the first single ploughing. To do that by manual which might be done by horse-labour may be thought uneconomical, but its strict economy cannot be doubted by one who has watched the process and seen weeds eradicated *for 6d. per acre,* which would else have been left to multiply in the succeeding turnip and corn crops, or have required a far more costly process of horse-labour, and an omission of the green crop on the fallow. This plan, therefore, is strongly recommended, not as a mere theory, but from its known practical results, and as a necessary step to the establishment of any system which lessens the time usually devoted to fallowing.

There is a farm in the immediate neighbourhood of Guild-

ford—that of Mr. Drewitt—which presents an instance of a perfectly-clean farm, and kept so by deep, clean ploughing, unsparing use of the horse and hand hoe, and *the invariable habit of spudding-up couch, crowsfoot, &c., from the stubbles*, and, in fact, at every possible opportunity. It has often been remarked that root-crops and corn are unmolested by wireworm upon this farm: the owner asserts that he starved them long ago by growing no weeds to sustain them in the absence of a crop.

With luxuriant green crops upon the fallows, and under admirable management, this farm carries a most unusual amount of sheep, horned, and pig stock, is consequently supplied with a great quantity of rich manure, grows very heavy crops of roots, plenty of rye and tares, and produces large crops of corn. To point out why land should be clean, and how to clean it, will be thought by all good farmers as unnecessary as it would be to descant upon the horrors of war; but, as some nations cannot be too well taught to reverence a just peace as the first step towards freedom and social advancement, so some farmers cannot know too soon the advantages enjoyed by their fellow-competitors, who make this cleanness the first step to a better and faster system of cropping.

Rye, tares, or ersh turnips are sown, immediately after harvest, upon stubbles intended for roots the following spring. Ersh turnips are planted on the warmest, most fertile sandy soils, aided, perhaps, by a little guano, when they produce excellent food in the following early spring for ewes and lambs, for stock-sheep, or for fattening sheep fed with corn. A good season is generally made for the succeeding root-crop, after one ploughing, unless fed off in wet weather, when more work may be required, according to the friability of the soil, and depending also upon the kind of implements used to pulverise it. The modern iron harrows and Crosskill's clod-crushers are too well known to need any recommendation.

Rye and winter tares are sown immediately after harvest, and, unless cropped by hares and rabbits, they present a lively green throughout the winter; and in early spring, when the winter's store of roots is consumed, they are ready to take their place.

Fatting sheep require corn, which is all the better for the ensuing crop. Hoggets or tegs, to be kept as stock and fattened the following winter, usually feed them without corn, depending upon how they can be kept till turnips come again.

Even the store-sheep, however, receive corn from those who recognise the soundness and true economy of the principle, that *all stock, from its birth to its death, should be constantly fattening as well as growing*, and it is to be attributed to the gradual reception of this principle that we have lately brought our sheep

and cattle to maturity so much earlier than under the old régime. Rye and tares are also excellent food for ewes and lambs; rye is fit to feed sooner than tares, and lasts good about a fortnight, after which the stalks become too hard and full of woody fibre. Tares are very nutritious, more so than rye, and can be cut for sheep, cattle, or horses, even when their seed-vessels contain seed. It often happens that more rye is sown than is wanted for food in the spring; that which is not fed is ploughed in for the root-crop, which is one of the best preparations for roots on light friable soils. The rye may be allowed to grow three or four feet high, and can be perfectly buried by attaching a stout chain to the head of the plough, which, with a sufficient weight at the end, folds over the left side of the beam, then passes under it immediately before the skim-coulter, and, with the weight passing along between the last-turned furrow and that to be turned next, the chain pulls every straw into its proper place, and effectually buries the whole without perceptibly increasing the draught.

Turnips or swedes are seldom sown without manure, even after a green crop fed with corn; certainly they never should be. No crop is more grateful for a judicious supply of manure than a root-crop—none can be more safely treated. If 25 tons per acre are grown instead of 20, and 20 are considered sufficient to feed on the land for the succeeding corn-crop, 5 tons can be removed at a trifling expense, and enable more cattle to be kept in the yard. The manures generally used are farm-yard manure, bones and ashes, superphosphate, and guano. Rich yard-manure is used successfully on any soil, though a little guano is a cheap addition. Bones and ashes, or superphosphate, are used, more or less, in every district, at the rate of about 2 quarters of bones and as many ashes per acre: they are chiefly confined to the sandy soils, the presence of their constituents not being so much needed on the chalks, where yard-manure is of more value: they are generally procured some weeks before the time at which they are required, and are well mixed together. While lying in this state fermentation takes place; and it is believed that, when well fermented, they are a cheaper manure than superphosphate, which is not in such general use, though still of great value and importance. Guano is very much in use, especially in districts where it would be a serious expense to send 10 or 15 loads of manure per acre to some distant and hilly field; while 2 or 3 cwt. of guano, costing (sowing and pounding included) 20*s.* to 30*s.* per acre, is a cheap, and at the same time a very successful, manure. A small quantity is sometimes used with the manures before spoken of, and scarcely ever without success. The crops of turnips grown vary in weight from 10 to

20 tons per acre. Swedes are grown from 15 to 25 tons per acre. The application of manures is too well known to need notice here; but of the various methods of applying artificial manures it may be here mentioned that, although the manure-drill has not come into use within the last four or five years, its *universal* adoption is of very recent date, and, with the horse-hoe, may be classed amongst our other great modern improvements.

By means of these implements we plant our root-crops, manure them, and afterwards hoe and scarify them, with a regularity and strict economy wholly unknown to our ancestors. In speaking of the green crops grown upon fallows, the culture of the mangold-wurzel must not be forgotten. It has lately assumed an important place among our root-crops. It is usually grown upon land which will not bear sheep-treading, and is carted off the land to be fed by cattle in yards, or by sheep, during the winter and spring months. With a supply of 4 cwt. of common salt, 2 cwt. of nitrate of soda, with 2 cwt. of guano per acre, at an expense of about 3*l.*, and with frequent and deep horse-hoeings, crops of 25 to 35 tons per acre can be grown. They are trimmed, carted, and stacked for about 1*l.* per acre. They are usually stacked near the yard where they are intended to be fed; if properly covered and ventilated they keep perfectly sound, and in the spring, even up to July and August, the water contained in them having decreased, and the saccharine matter having greatly increased, they are found to be invaluable food for cattle, pigs, or sheep.

We have now spoken of those green crops which occupy a prominent position upon the light-land fallows. Rape and mustard are in occasional use, but they more properly belong to heavy land, where the swede and turnip are necessarily much less grown. Passing now from the first or root-crop portion of the modern four-course system, we come to the second or barley portion. There is but little to notice here: wheat is sometimes sown instead of barley; but the present price of the latter as compared with that of the former will secure its extensive growth. The usual yield of barley is from 4 to 7 quarters per acre. Both the chalks and the sands and loams produce barley for the maltster, but the finest comes from the best loamy soils. Where the roots are drawn from the land it is usual to plough in, or sow immediately after the plough, about 2 cwt of guano. This has a most marked effect, and generally secures a crop quite as good as that grown where the roots were fed on the land by sheep. If the root-crop is not so good as usual, or if the land is thought able to bear more manure, or if the barley looks weak after it is up, a little guano, or a little nitrate of soda, is often applied, and, if judiciously used, and showers fall to dissolve the

manure, it almost invariably answers a good purpose. A very short time has elapsed since the breaking up of the old and very prevalent notion that barley, after being mown, must be exposed to the action of nine dews. In the very finest weather perhaps this custom might be beneficial, as it would improve the colour of the grain, and make it thrash better; but as this long delay not only secures the effect of the nine dews, but, very often, the injurious influence of as many showers, and the expense of constant and sometimes unsuccessful attention to prevent it from growing, this tardy process at length gave way to the present plan of housing as soon as the corn and straw are in proper condition. In the third quarter of our system there is a considerable change, owing to the substitution of peas or winter beans for a portion of the seeds. To keep up the exact rotation seeds should be sown with all barley or wheat planted after the root-crop. Hay, if reckoned at its market price, is found to be the dearest food which stock can possibly eat. Partly owing to this, partly owing to a greater economy of hay, by cutting hay and straw together in our chaff-cutters, and also owing to a higher degree of fertility, attained by the different management of our fallows, and to some other causes, it is now common to leave a portion of the barley-course free from seeds, to be planted with winter beans in the autumn, or with peas the following spring, all coming for wheat in due course. Winter beans grow on much lighter soils than the spring varieties, tick, massagan, &c.

When the land is perfectly clean it is an excellent plan, at the usual time of grass-seed sowing, to hoe in some trefoil and Dutch clover among the winter beans; they produce some autumn food for sheep, and, by forming a kind of ley, tend to solidify the land for the succeeding wheat-crop. After the peas are harvested, and with favourable weather, it often answers a good purpose to scarify the surface of the pea stubbles about two inches deep, to destroy all weeds, and stir in at the same time some rape or mustard, which gives increased firmness to the land, and produces grateful food for the succeeding wheat-crop.

But, however clean the land may be, however much artificial and yard manure may be at command, this deviation from seeds to peas and beans requires all the judgment and all the knowledge which can be summoned, of the food required by, and the conditions necessary to secure, a good wheat-crop. For, in comparing a crop of beans and peas with a crop of hay, we must not forget that we shall often find the succeeding wheat-plant revelling on a good clover ley, but sickened and root-fallen when planted after beans or peas. Instances out of number could be given, showing that they almost invariably injure the succeeding wheat-crop. Having access to artificial manures of almost every

kind, we may soon be able to overrule this objection, but, at present, a wheat-crop cannot be built upon so secure a basis as that of a good clover ley. The pecuniary advantage of a pulse-crop, beyond that of a crop of hay, with the quantity of sheep-feed which generally follows when the land is highly cultivated and manured, is less than might be imagined; it cannot be reckoned at more than 1*l.* per acre, upon a fair average. The hay-crop, with its after-feed, is worth at least 4*l.*, and 4 quarters of beans or peas, at 30*s.* per quarter, making 6*l.* per acre, is certainly a good average. Then the expense of growing the pulse is from 10*s.* to 1*l.* greater than that of growing hay, and the land is left in worse condition for wheat. It must also be remembered, on the other hand that clover cannot be grown every four years, though rye-grass, Dutch clover, and trefoil can; but a ley should be made without rye-grass if possible, as it takes up nearly the same mineral constituents as are so much required to give stiffness to the wheat-straw. Therefore, in making this deviation, great attention should be paid to the prospective advantage or disadvantage to the succeeding wheat-crop. By dividing the quarter assigned to clover, &c., into one moiety planted with grass and the other with peas or beans, better leys can be secured, as clover need then be sown but once in eight years on the same moiety, which will remain an advantage so long as clover continues to baffle every effort to make it a more constant and a more secure crop. When beans are to be followed by wheat it is a great advantage to the wheat to manure them rather heavily with woollen rags, tanyard hair, or any other powerful manure which does not decompose quickly enough to be more than partially appropriated by the bean-crop, and which continues to decompose and to afford valuable constituents for the wheat-plant. As has been said before, and as all farmers know, the great evil to be apprehended in wheat after beans is its being rootfallen, and the most searching attention should be given to find some panacea for so fatal a disease. On different soils, and on the same soils under different treatment, the remedies must vary, but it is often found that the evil is greatly avoided by planting unusually late in the autumn, and by compressing the soil to an unusual degree. It is of no use to manure with a more sparing hand; on the contrary, an eminent farmer, living near Guildford, late of Send, Mr. John Drewitt, brother to the gentleman already mentioned, having a field of wheat after beans, which had grown with great luxuriance through the spring, at the time when he supposed it would change its lively green for pale yellow, sicken, and fall, anticipated its wants by sowing broadcast a little guano by way of experiment upon a portion of this field. The yield of corn from the part sown with guano

was 32 bushels per acre, with fine stiff straw, while that from the adjoining part not sown with guano was rootfallen, and produced less than 16 bushels. This was a bold step to take; but as it has been the means of producing such a result from an apparently too luxuriant plant, which, without this extraneous help, would have become rootfallen, yielding barely half the quantity, it is an experiment which may be carefully tried further, and, however paradoxical it may appear on the face of it, its success in one instance at once makes it a question of great interest.

The intimate connexion between the grass or hay and pulse crops with the succeeding wheat-crop has made us, almost unconsciously, step from the third quarter of the four-course system to the fourth. But we must return to the moiety of the third quarter sown with grass. However much we may economise hay by cutting straw with our chaff-cutters, and by different modes of feeding stock, hay is still a very valuable, and it may be said, an indispensable crop; and it is to the interest of the farmer to apply the same principle to the culture of his grass or hay crop as he should rigidly apply to all others, namely, to *grow the largest-possible quantity in the shortest-possible time.* The seeds generally sown, such as clover, trefoil, Dutch clover, or rye-grass, produce good crops from good land, well cultivated, without any special manuring. But, as a general rule, some yard-manure spread over the seeds during winter, or from 1 to 2 cwts. of guano sown broadcast in early spring, is found to exercise the same productive power over these crops as those manures do upon all others to which they are properly applied. Upon the sandy soils 2 cwt. per acre of gypsum is often used. Its working is rather mysterious; sometimes its effects are very marked, at others it has no effect at all. If it works well once in four years it is said to pay for every year's trial. The first crop of hay being removed, if the weather is showery and the land well manured, the clover soon springs up again, and, in a few weeks, an abundant supply of green food is at hand, to be cut for cattle in yards, for the farm-horses, or to be fed by lambs or sheep. Even a third crop is often obtained, which lasts till the earliest turnips are ripe.

We come now to the fourth quarter of the four-course system—to that crop which has always been the English farmer's peculiar care, and to the benefit of which he has directed his main efforts. It has now become evident that the wheat-crop must still receive a legitimate share of calculation and forethought, and yet not be of pre-eminent importance; no traditionary fame must be attached to it, but the economy of perfect cleanness, the culture of green crops, the fattening of stock, the growth of

other and equally profitable cereals and pulse-crops, the wise application of cheap and necessary manures—all must be regarded as vital points, and under such management there need be, there *is* no fear, that the wheat-crop will suffer from the increased importance given to the crops which precede or which follow it. On the contrary, while there have been so much more energy and skill directed to other branches of farming, the average growth of wheat has gradually increased. This fresh spring of energy invigorates every section of the art of which we treat; and assuredly, as year after year we invoke the aid of our latent energies, we shall see a proportionate increase in the produce of our crops. So much attention has so long been paid to the growth of wheat, that there is but little to notice of marked change; still the increased average growth shows that a gradual improvement has taken place in preparatory management.

The almost universal use of the drill is of recent date, and its rapidly-increasing popularity is sufficient evidence of its sterling value, and no doubt rewards the labours of the implement-makers, whose ingenuity, energy, and skill supply the British farmer with an endless variety of tools, the perfection and manifold uses of which strike the foreigner with amazement, while their signal use and advantage are proved by the ease with which they have worked a revolution among, and yet gained the goodwill of, those for whose use they were invented; a class, if not prejudiced in favour of old habits, by no means celebrated for any incautious love of change or innovation.

It is needless to point out the advantages of drill-husbandry, as applied to planting wheat, over the old mode of sowing broadcast. The minute regulation of the quantity of seed to be planted, the regularity with which that quantity is deposited at equal distances and at equal depth over its allotted area, are well-known facts, as are the subsequent advantages gained by the use of the hoe, and the more perfect admission of the solar and atmospheric influences. Dibbling by hand is in partial use: it is decidedly the mode by which a less quantity of seed may be used; and, when wheat is dear, the saving of two or three pecks of seed may cover the increased expense. It is also of some advantage upon land which, from wet weather or from any other cause, is unable to bear the roller, and is therefore grateful for the solidity given it by the dibbler and his droppers.

Sowing wheat broadcast is almost an obsolete practice. It is only barely tolerable when a good ley has been well ploughed and pressed, so that the corn falls almost entirely into the seams, and rests upon a sound and therefore congenial bed. An important and almost insensible change has lately taken place in

the quantity of wheat planted per acre. The numerous reasons for and against thick and thin sowing have been advocated often enough to be very well known. It would be well for those who contend upon this question to remember that no universal law can be laid down upon the matter. The time and mode of planting the wheat, the crop after which it is planted, the kind and quality of wheat used, the natural fertility or poverty of the soil, its tenacity and aspect, and the artificial power given it, all exercise an important influence upon the quantity of seed required. Still, that wheat is planted considerably thinner within the last few years is certain, and is perhaps mainly attributable to its improved quality obtained by much earlier housing, to its more perfect planting by means of the lever-drill and dibbler, and to its being better supplied with manure, which gives it more power to branch and thicken.

The quantity planted upon the kind of land and in the district here spoken of, is from 4 to 6 pecks per acre when dibbled, from 6 to 8 pecks when drilled, and from 8 to 12 pecks when sown broadcast. If every farmer who plants 100 acres of wheat each year can plant it as well with 6 or 8 pecks as it was planted some years back with 8 or 10 pecks, 50 bushels are saved from every 100 acres planted, and it is some consolation to know that cleanness and high farming tend to diminish the quantity of seed necessary, as well as to increase the crop grown. At the same time too little seed may be used, as well as too much; the soundest economy is to use that quantity which produces the best crop in an average of years.

Within the last few years artificial manures have risen into great and increasing importance, and if the supply from the farm-yard is less than is required, or if the wheat looks in the spring as though it would bear an additional stimulus, some extraneous help may be given, either in the form of guano, nitrate of soda, or perhaps common salt. The fact that these manures, applied as top-dressings in the spring, are more in use than they were, is good evidence of their salutary effect. Common salt is used principally upon the lighter loams and sands, at the rate of 2 to 4 cwt. per acre. Its general effect is to stiffen the straw without increasing its bulk, and to assist in the perfect filling of the ear.

The most remarkable case of the effect of salt alone upon the actual yield of corn that ever came under the writer's own observation was upon the farm of Mr. John Ellis, of Artington, near Guildford. The following are extracts from a letter received by the author from Mr. Ellis:—

"I will, in the first place, give you the results of the particular experiment, to which you have referred, made by me with common salt, in the summer of

1846, on a quarter of an acre of land, a sandy loam with a gravelly subsoil: preparation, a clover and bent ley, with about eight loads of dung per acre, and after the rate of 2 cwt. per acre of common clean coarse salt, sown about the middle of March:—

No Salt.	lbs.	*With Salt.*	lbs.
8 bushels head-wheat, $61\frac{3}{4}$ lbs. per bushel	494	9 bushels head-wheat, 61 lbs. per bushel	549
1 bushel tailing ditto . . .	54	1 bushel 5 gallons tailing . .	90
	548		
Balance in favour of salt . .	91		
	639		639

"The weight of straw on the quarter-acre salted was 786 lbs., and on the portion not salted 696 lbs., showing 90 lbs. most straw where the salt was used. Therefore the difference in this experiment in favour of the salted wheat was after the rate of $6\frac{1}{2}$ bushels per acre, and 360 lbs., or 10 trusses, of straw, at an expense of about 4*s.* per acre, including the sowing."

Mr. Ellis also says,—

"I believe that in a portion of another field, in the same year, the results, could I have conveniently ascertained them, would have been still greater in favour of salt. I have continued the use of salt for nearly all my wheat every year since, and in nearly all cases with very beneficial results. I frequently salt the leys in the autumn, either previous to ploughing, or at least to sowing, as I consider in some soils it checks the ravages of the slug and worm. I have usually seen the most benefit from salt when applied to wheat after ley, and I think that it is least beneficial on heavy clay land, where, if much is used, it appears to make it run together, and is consequently unkindly to vegetation. I now usually sow from $2\frac{1}{2}$ to 4 cwt. per acre. From the experience and rather close observation and comparison of the last few years, I am much in favour of using the clean, coarse salt, in preference to the Hide salt, or to the dirty refuse sold as manure salt. I think 2 cwt. of the clean equal to 3 cwt. of the other. I have tried salt on oats and barley, but with very little apparent advantage: with barley it sometimes appears to stiffen the straw and make it brighter, but the grain has been inferior to that not salted, being much more steely."

Of the effect of nitrate of soda and guano, Mr. Ellis kindly gives me his experience:—

"I have never been very successful in the use of nitrate of soda to the wheat crop, but this may arise from my land being already sufficiently charged with the straw-growing material; but I have derived great benefit on sandy loams when I have used it to my mangold-wurzel and Swede turnips, especially the latter. When my land has not been in sufficiently good condition to bring on the wheat-plant satisfactorily, I have a high opinion of an application of about $1\frac{1}{2}$ cwt. of guano mixed with 2 cwt. of salt per acre, sown as a top-dressing at the end of February or the beginning of March."

Mr. Ellis's farm consists principally of a deep, rich loam, and had been in its present high state of cultivation for many years previous to the use of the manures now spoken of.

In some cases in which salt has been sown with wheat at the time of planting, it has had an injurious effect, destroying some of the plants, and retarding the appearance of the whole. When

sown upon the living plant in February or March, it has no pernicious influence, but cleanses it from worms and grubs, as well as from many weeds, by checking and destroying their growth.

Guano is frequently sown as a top-dressing for wheat in the spring, generally from 1 to 2 cwt. per acre. If used in showery weather, and when spring has fairly set in, it has an immediate effect upon the growth and colour of the plant, hastening its growth and darkening its colour. It invariably increases the quantity of straw, and, when used judiciously, increases the crop of corn by several bushels per acre. One of the best methods of sowing guano broadcast is to mix with it a sufficient quantity of common salt to prevent the loss of the dust which so commonly escapes, and by giving it more weight to enable the sower to distribute it more evenly.

Nitrate of soda is used with like effect upon chalks and sands: like guano, its first effect, if sown in showery weather, and when the wheat is beginning to grow, is to give the blade a darker hue. Half, three-quarters, or one cwt. per acre is generally applied, either by itself, or being previously mixed with salt: where salt is sown, it is mixed to secure its more equal distribution and to economise the labour of sowing. This manure invariably increases the quantity of straw, and, when wisely used, it increases the crop of corn, sometimes to the extent of 3 sacks per acre. From various experiments made by Mr. John Evershed, of Albury, Surrey, an increase of 3 sacks has been secured in some years by using 1 cwt. of this manure, while in other years, when the weather has been less favourable, the crop would have been as good without it. Still upon farms where it has once been used, it is almost invariably applied more or less every year. In a wet spring and summer it has a tendency to produce blight and a weak bent straw, which becomes lodged too soon to allow the ears to fill well. And this is always the case where too much has been sown upon land already richly manured. But when sown early enough to be dissolved and carried to the roots of the plant, if a dry summer follows its effects are remarkable.

From various experiments and calculations, it appears that, comparing the value of guano with that of nitrate of soda as manure for wheat, the money value of the quantities required of each to produce the same effect is nearly equal.

There is a singular instance of the value of nitrate of soda as a manure upon Mr. Evershed's farm. One of his fields, a useful light loam, lying at the foot and side of a sterile sandy mound, near the base of a range of chalk hills, has a footpath crossing one upper corner, which divides 50 rods of lighter land from the rest of the field. The whole field, including this

corner, has been farmed according to the four-course system during the last 30 years. Omitting this corner piece of 50 rods, the remainder of the field has, during the period above mentioned, been manured with as much farm-yard manure as is thought consistent with good crops and with good farming. During the last 15 years this corner piece, cut off by the path, has been cultivated and cropped exactly like the rest of the field, but, instead of being manured with the same manure, *it has received 50 lbs. of nitrate of soda to each crop, always sown as a top-dressing.* All roots have been removed, and literally *no organic manure has been permitted to fertilize this corner*, with the exception of the grass-ley, the wheat and barley stubble, and the leaves of the roots which grew upon it. Care having been taken to sow the 50 lbs. of nitrate of soda when showers were likely to fall, it has had an immediate effect upon the growing plant, and *the crops have been uniformly as good as upon the rest of the field. The experiment is still carried on, and is as successful now as it was when first begun.*

The idea of the writer has been to give some of the general results of modern experience in an authentic and tolerably concise form. It is impossible to transcribe here all the minute variations in the rotation of crops and in the process of raising them, for every farmer shows a certain idiosyncrasy in his mode of management and cropping; but the present general and improved method of cultivating such land, as is here alluded to, will be found to harmonize very closely with what has been roughly sketched.

The improvements which have lately been introduced into our British agriculture tend to perfect every department. They are both various and striking, and as important as might well be expected from the progressive tendency of the age in which we live, and from the attention directed by the wealthiest and most energetic people of the world to what is said to be the most important branch of their national industry. But we must be able to distinguish that which really tends to perfect our economy from any spurious imitation, which, like other counterfeits, may be paraded before our eyes in a very alluring form.

For a farm to be crowded with men, horses, and machines, neither proves that the principles pursued on that farm are good or bad. Nor would the knowledge that the returns from the sale of produce were double what they were formerly prove that the real profit had increased at all. The man who can produce from a given quantity of land 3000*l.* at a cost of 2500*l.* is a more sagacious farmer than the man who can produce 6000*l.* from the same quantity of land with no profit at all. On the one hand, it is sometimes very easy to persuade a man of small

capital that he can plough and sow a very large farm, and the idea of being a large farmer pleases him; but if he acts upon this advice, he soon finds out to his cost that he would realize a much larger percentage for his capital upon a farm of half the size, and that he has been tempted to sin against every principle of economy and good farming. On the other hand, a man of large capital may be persuaded to take a moderate-sized farm, and, by way of setting an example to the neighbourhood, to invest an amount of capital in a superabundance of stock, in unnecessary implements, and in labour, which may make it absolutely impossible for the farm income to cover the farm expenditure.

The latter is a comparatively rare case—the former a too common one, and is undoubtedly one of the most unhealthy elements in the agricultural atmosphere. That a purifying influence is at work none can doubt who see around them the working of capital and energy in the midst of our rural districts, while thorough drainage, felling of timber, grubbing, and I wish it could be said the erection of new farm-buildings, are perceptibly changing the aspect of the country.

As to our agricultural implements, they occupied a prominent place at the late gigantic and almost fabulous collection of the choicest works of all the united industries of the world. Hundreds of thousands of spectators, while they wondered at and admired the skill which had supplied these pieces of mechanism, were also impressed with the advancing dignity of the art which had called them forth.

The most sagacious use of capital in farming will doubtless be made by those who accept fearlessly and honestly the evidence supplied by such facts as these, and who recognize the law of constant progression as inseparable from the true interests of agriculture. That numbers of farmers have long been eager to adopt every improvement, and willing to assist their less enlightened and less patriotic neighbours, no one can for a moment doubt. And these are the men who have the clearest idea of that amount of capital which can be used upon a given quantity of land to secure the largest percentage. Without specifying the amount necessary for every 100 acres, if we could get a verdict on the point from such men as we have spoken of, judging by the test of their own actual practice, it would be a verdict which would associate the best farming with a very large amount of stock, and a great consumption of hand, horse, and machine labour, the whole presided over by never-satisfied knowledge and searching intelligence.

In tracing the steps of improvement and in recognising the features of progression, as we see them assume their legitimate

and approved places either by the side of, or in the place of, the customs of our ancestors, we are sensibly impressed with one important fact—that these very signs which herald the approach of a yet more economical system of agriculture, and proclaim the firm, steady march of improvement upon improvement, warn us that those who do not vigilantly watch the advent of each new-born pledge which the prolific union between science and practice will assuredly give birth to, must inevitably be passed by, and left behind in some obscure by-roads to waste their remaining days in lamenting the loss of the bold independence of their forefathers, and in bidding sad farewells to that material prosperity which flourishes around them, but is no longer within their reach.

VII.—*Notes on the Geology of the Keythorpe Estate, and its relations to the Keythorpe System of Draining.* By Joshua Trimmer, F.G.S.

In various communications to the Royal Agricultural Society and the Geological Society, I have insisted on the following points :—

1. The important influence exercised by the superficial deposits on the distribution of soils.

2. The division of those deposits into erratic tertiaries, or northern drift, and warp-drift.

3. The division of the erratic tertiaries again into upper and lower erratics : the lower erratics consisting of boulder clay, possessing peculiar characters found in no other marine strata ; the upper erratics composed of rolled gravel and sand, approaching more the characters of ordinary tertiary strata, but distinguished from them by certain marked peculiarities.

4. The distinctness of the warp-drift — a deposit which generally forms the surface-soil,—and its subsequent origin to that of the erratic tertiaries ; its presence in those districts where the erratic tertiaries are absent, and its diffusion over their denuded surface where they are present.

5. The indented surface of the beds, whether of the erratic tertiaries or of the older strata, on which the warp-drift rests, presenting a series of irregular ridges and furrows.

6. I suggested that the contradictory statements which abound respecting the superior efficacy of deep or shallow drains, of drains at wide or narrow intervals, of drains following the fall of the ground, or crossing it, might, perhaps, in many cases be reconciled by observing whether the drains were parallel or transverse to these natural furrows and ridges.

In corroboration of these views I referred to a statement made

by Mr. Austen in a communication to the Geological Society, to the effect that the occupiers of soils near Guildford, resting upon a subsoil of clay so furrowed, had found that drains across the ridges and furrows dried a much larger area than drains parallel to them.

When these views were announced in a lecture before the Royal Agricultural Society, it appeared that a system of draining by drains transverse to these furrows and ridges, called in Leicestershire "claybanks," had been practised for many years by Lord Berners at Keythorpe, with great success, both as regards efficacy and economy; and that these results had been obtained by the tentative process, without any reference to geological investigations, which they so beautifully confirm. Having recently had an opportunity, through the kindness of Lord Berners, of examining the Keythorpe estate, with the advantage of his Lordship's explanations on the spot respecting the depth, distances, and direction of the drains and of the trial holes by which those points were determined, I propose in this communication to give a slight sketch of the geology of the estate, and of the Keythorpe system of draining. I give the latter in the hope that Lord Berners may be induced to illustrate this part of the subject by the publication of some of those details of which his Lordship possesses the most minute and elaborate records, proving incontestably the economy of the system. Its efficiency must be evident to all who have witnessed the present condition of the land.

Geology of the Keythorpe Estate.—The whole of this property which I have seen is on the lias, and principally on that part of the lias called the marlstone; the lias in this portion of its range is less known to geologists than nearer its northern and southern extremities; the marlstone part of the series appears to consist here chiefly of clay, with some alternating beds of sandstone; the former yields an excellent building stone, as the buildings on the estate, including Keythorpe Hall, abundantly testify. A stone approaching the character of the Uppingham stone (at the junction of the lias and inferior oolite), and suitable for barn-floors and for quoins, was found in digging a pond at Old Keythorpe. Though these beds of sandstone and limestone are only worked at one or two points on the estate, there can be little doubt that they might be found at accessible depths on other parts of it and on the neighbouring properties, if it were deemed desirable to search for them by boring along the strike of the strata.* I have reason to believe that the Cleveland ironstone,

* With men expert in the use of boring tools, and a judicious selection of the points for boring, it is surprising how cheaply ground may be proved in this way to the depth of 15 or 20 feet, in the absence of obstruction from beds of stone. Such obstruction would in this case be the discovery of the thing sought.

respecting the geological position of which little is known, is situated in the marlstone division of the lias. This point should be determined by a careful examination of the strata in which it occurs, at the localities where it is worked, and by tracing their outcrop through the intermediate space.

The estate contains soils all ranking as clay, but of very different values; the value, in their natural state, varying from less than 20*s*. to more than 50*s*. Under the ordinary system of Leicestershire management, they are devoted almost exclusively to permanent pasture and summer grazing. By draining and subsoiling, or double ploughing, portions have been converted into arable land, which yields splendid crops of swedes, wurzel, and clover, thus furnishing a valuable auxiliary to the grass-land for the winter feeding of stock.

By the system of draining pursued, the worst soils of this estate, whether converted to arable or retained as pasture, have been doubled in value.

The natural variations of these soils do not arise from variations in the mineral characters of the substrata of lias, but from variations in the distribution of the superficial deposits. These consist of the three varieties which I have enumerated—namely, boulder clay, or lower erratic tertiaries; gravel and sand of the upper erratics; and warp-drift. The lower erratics present their usual form of boulder-clay or till, and contain large chalk flints, subangular fragments of chalk, and other detritus extraneous to the lias; the upper erratics consist of gravel containing chalk flints, and so much limestone that the larger fragments are collected for lime-burning: both deposits have been much denuded. From the rarity of sections, and from the covering of warp-drift, the boulder-clay is not often exposed; but some holes, which Lord Berners caused to be opened for my inspection, clearly established its presence, and showed that the rolled gravel rests upon it. I observed similar boulder-clay, several years ago, on the summit of the oolitic ridge near Desborough.

The gravel covers many of the tabular hills of lias at Keythorpe, to the depth of 12 and 15 feet.

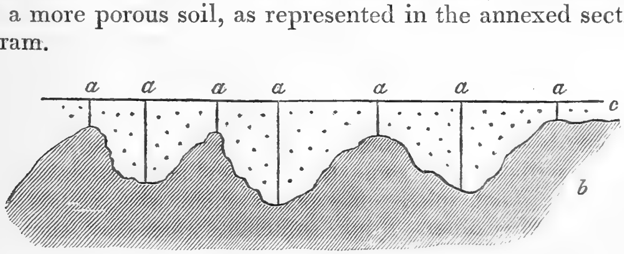
The variations of soil follow the analogies which I have observed in other districts. The poorest soils are upon the steep sides of the hills where there is little or no covering of warp-drift on the lias clay. There are better soils on the summits of the hills, consisting of a warp-drift of clay or clay-loam resting on the rolled gravel. These soils are valued at 30*s*. the acre. The best soils of all are in the bottoms of the valleys, or on the long slopes where there is a deep covering of warp-drift. These are valued at from 40*s*. to 60*s*.

The estate constitutes an upland district near the head waters

of the Welland. If we follow its stream downwards for eight or nine miles, we find in its valley still richer grazing-grounds, consisting of deep warp-drift, holding a position intermediate between the mowing-grounds, which are alluvial, and the poorer soils on the steep sides of the hills bounding the valley, where there is scarcely any warp-drift, and where the strata of lias are either at the surface or near to it.

On my suggesting that it would be worth trying, whether some of the finer calcareous gravel would not be a beneficial dressing for these clay soils, Lord Berners recollected that some had been spread several years since on some pasture land, and also on part of an arable field consisting of some of the stiffest clay on the estate; a considerable superiority has been observed on the crops of the arable field so treated. This superiority, however, had hitherto been attributed to a difference in the cultivation and rotation. On the pasture land, which had been covered with this gravel to the depth of 1 or 2 inches, no ambiguity could arise from those causes; and there also the improvement was very manifest. In consequence of the suggestion which I offered having brought these points to remembrance, these experiments will be repeated. Knowing that limestone-gravel forms the staple mineral manure of Ireland, and seeing the result of previous experiments at Keythorpe, I look with great interest, and with the utmost confidence of success, to those now in contemplation.

The Keythorpe System of Draining.—The peculiarities of the Keythorpe system of draining consist in this—that the parallel drains are not equidistant, and that they cross the line of greatest descent. The usual depth is $3\frac{1}{2}$ feet, but some are as deep as 5 and 6 feet. The depth and width of interval are determined by digging trial-holes, in order to ascertain not only the depth at which the bottom water is reached, but the height to which the water rises in the holes, and the distance at which a drain will lay the hole dry. In sinking these holes clay-banks are found with hollows or furrows between them, which are filled with a more porous soil, as represented in the annexed sectional diagram.



a a Trial holes.
b Clay banks of lias or of boulder-clay.
c A more porous warp-drift filling furrows between the clay-banks.

The next object is to connect these furrows by drains laid across them. The result is, that as the furrows and ridges here run along the fall of the ground, which I have observed to be the case generally elsewhere, the submains follow the fall, and the parallel drains cross it obliquely.

The intervals between the parallel drains are irregular, varying, in the same field, from 14 to 21, 31, and 59 feet. The distances are determined by opening the diagonal drains at the greatest distance from the trial-holes, at which experience has taught the practicability of its draining the hole. If it does not succeed in accomplishing the object, another drain is opened in the interval. It has been found, in many cases, that a drain crossing the clay-banks and furrows takes the water from holes lying lower down the hill; that is to say, it intercepts the water flowing to them through these subterranean channels. The parallel drains, however, are not invariably laid across the fall. The exceptions are on ground where the fall is very slight, in which case they are laid along the line of greatest descent. On such ground there are few or no clay-banks and furrows.

The greater part of the estate had previously been drained with drains 2 to 2½ feet deep, laid along the line of greatest descent, and they had proved a complete failure. The present system has stood the test of about 15 years' experience; and of its efficiency there can be no question. Lord Berners does not consider a field sufficiently drained till sheep can consume the turnips on the ground upon these strong soils without poaching the land. The difference in the texture of the soil before and after draining is very remarkable. A tenacious clay appears converted into a friable loam. With regard to the economy of the system, that will be best shown by comparing it with that of equidistant drains, laid along the declivity at the distances suited to such a soil, stating the difference between the two systems in perches of drain and hundreds of tiles per acre. By these means the calculation is freed from all complexity arising from local variations in the wages of labour and cost of pipes, tiles, or broken stones. The saving in length of drain and quantity of materials for forming the conduit, are constant quantities for that description of soil, wherever situated; the money value of labour and materials varies in different localities. There are, moreover, great discrepancies in practice with respect to the nature of the conduit. Some prefer pipes of an inch bore, some like larger diameters; some advocate cylindrical pipes, others pipes with a flat sole; some prefer them with collars, some without; while others think sufficient water-way cannot be obtained except with the old horseshoe tiles and soles. Lastly, there are some localities to which broken stones are better

adapted than pipes or tiles of any kind. In order to make a fair comparison, it is necessary to compare like things with like, collared pipes with collared pipes, tiles and soles with tiles and soles, and so forth. Lord Berners uses pipes of 1½ and 2 inches diameter for the drains, and 3-inch pipes for the sub-mains, both without collars. I should have preferred collared pipes; but his Lordship's argument in favour of those which he uses is unanswerable: "I find them succeed in this soil without collars, and they are cheaper." For the junctions, branch pipes are made, the branches joining the main pipe at various angles. His Lordship informs me that he finds them useful for forming, not only horizontal, but vertical junctions, when the parallel drains are shallower than the submains into which they discharge.

On entering on the comparison proposed, it should be premised that on a soil so tenacious, the deepest drainers, on the principle of equidistant drains laid with the fall of the surface, would not place their drains at wider intervals than 8 and 10 yards. I believe few would exceed the smaller interval. At intervals of 8 yards there would be 110 statute perches (of 16½ feet) to the acre. The proportion of submains depends on the form of the field and the contours of the surface. Allowing that the drains shall not exceed 10 chains, or 220 yards, without discharging into a submain, there would be, under the most favourable conditions of form and contour, 4 perches of submain; making a total of 114 perches of drains and submains. At intervals of 10 yards there would be 88 perches of drain and 4 perches of submain, as in the last case; total, 92 perches. Let us now compare this with the Keythorpe system. Lord Berners has a map, on which the drains of each field are laid down, and on which is recorded the amount paid for labour in draining it. Out of four cases given me by his Lordship at hazard from this map I select the highest and the lowest; the highest is Over Hammer. Its area is 7 acres, drains generally 3½ feet deep, with some 6 feet deep. The customary measure for draining in this part of Leicestershire is very anomalous—*a linear acre of* 24 *yards.* To avoid confusion I reduce the quantities thus stated to yards, and find that there are

3½ feet drains	2436 yards
6 feet drains	204 ,,
Total	2640

This is equal to 480 perches; and as the field contains 7 acres, there are 68½, or say 69 statute perches of drains to the acre. This includes submains as well as parallel drains.

The lowest case is No. 39, area 3½ acres; length of parallels

and submains, all 4 feet deep, 987 yards, equal to 179 perches, or say, 51 perches to the acre.

In Over Hammer, then, we have 69 perches, and in No. 39, 51 perches; average of the two, 60 perches to the acre.

With equidistant drains laid along the fall of the ground at intervals of 8 yards, we should have, as stated above, 114 perches; on the average of the Keythorpe system, 60 perches; saving by the Keythorpe system 54 perches, containing 891 pipes, of a foot long.

On the equidistant system and 10-yard intervals there would be 92 perches; and deducting the average of the Keythorpe system, we have 32 perches of drain saved by it, containing 528 pipes.

Those who would calculate the sum to be saved by draining an estate on the Keythorpe system, have only to apply the above data to the customary local prices of labour and materials in their respective districts. The following may be taken as illustrations of some of these local variations:—

Two farms were drained on the London clay by an eminent and experienced drainer. The depth of the drains was 4½ feet, that of the submains 5 feet, width of interval 8 to 10 yards. From what I saw of the soil and subsoil, and the irregularities at their junction while the drains were being dug, I have no doubt that the Keythorpe system would have applied to the case. For the drains 1¼-inch cylindrical pipes were used, unless the length of drain exceeded 10 chains without joining a submain, when the bore was increased to 1½ inch, both collared. For the mains and submains, pipes of 3-inch bore were used without collars: the cost of these, to be delivered on the land—the number to be determined by measurement of the drains, all flawed pipes being rejected—was, for 1¼-inch pipes, 25*s.* the thousand; for 1½-inch, 28*s.*; for 3-inch, 35*s.* The average prices for digging drains were,—for mains and submains, 5 feet deep, 1*s.* the statute perch. The parallel drains averaged 8*d.* the perch in winter, and 9*d.* in summer, for the draining operations were carried on through the summer, which was also the Keythorpe practice. If we suppose half the drains to have been at 8 yards, and half at 10 yards (but there were more of the former than of the latter), the following would have been the saving by the Keythorpe system:—At 8-yard intervals there would have been 114 perches of drains and submains; at 10-yard intervals, 92 perches to the acre; average, 103. The average of the Keythorpe system is 60 perches to the acre—the difference in its favour 43 perches, containing 709 pipes. The total saving in money would then be—

43 Perches.			£.	*s.*	*d.*
4 Mains, at 1*s.*			0	4	0
39 Drains, at $8\frac{1}{2}$*d.*			1	7	7
			£1	11	7
709 Pipes.	*s.*	*d.*			
66 Mains, at 35*s.*	2	3			
643 Drains, at 25*s.*	16	0			
			0	18	3
			£2	9	10

At the above rates, the saving by draining a farm of 500 acres on the Keythorpe system would be more than 1200*l.*

In Leicestershire Lord Berners pays for $3\frac{1}{2}$-feet drains, equal to nearly 7*d.* the statute perch; and for 6-feet drains, equal to 1*s.* $4\frac{1}{2}$*d.* the statute perch. In Norfolk his Lordship pays about one-fifth less for labour. On the other hand the tiles made on the estate would not be valued at more than 16*s.* the thousand for $1\frac{1}{2}$-inch pipes without collars, and 35*s.* for 3-inch pipes.

Others again, in other localities, would estimate both labour and materials lower, viz., for digging $4\frac{1}{2}$-feet drains, $6\frac{1}{4}$*d.* the statute perch, and for inch pipes 13*s.* the thousand.

At this rate the saving by the Keythorpe system over that of equidistant drains, half of them at 8 yards distance and half at 10 yards, would be as under:—

	£.	*s.*	*d.*
43 Perches of drain, at $6\frac{1}{4}$*d.*	1	2	4
709 $1\frac{1}{4}$-inch pipes, at 13*s.*	0	9	2
	£1	11	6

The saving, even at these low prices, of 1*l.* 11*s.* 6*d.* the acre is an important consideration.

I should state, however, that Lord Berners has informed me, since the preceding calculations were made, that there are *a few, and a very few fields* on which the drains have been as frequent as if laid on the equidistant principle at intervals of 8 yards. The fairest mode of estimating the advantages of the Keythorpe system would, therefore, be by comparing the total number of perches of drain on 500 or 1000 acres, with the total number on another tract of land of the same extent and of the same kind of soil on which *all* the drains have been laid on the equidistant system. Lord Berners possesses, as I have said, the amplest materials for such a comparison; and his Lordship would confer a great public benefit if he would incur the trouble of having it made.

In conclusion I would remark, that as a preliminary to drain-

ing an estate the presence or absence of these natural furrows between the warp-drift and the substratum should be determined by numerous trial-holes, as well as their average depth and direction. They will generally be found on land with a considerable fall, and they will run in most cases—though I have seen exceptions—in the direction of the fall.

In making these trial-holes the principal expense attending the construction of a map of the soils, subsoils, and substrata of an estate will be incurred. It will, therefore, be good economy to record this information on a map—and there are few estates without one, or for which one cannot be obtained from the Tithe Survey Office. It has so long been the custom with agriculture not to look below the surface, and with geology to look only at the substrata, that there are, I believe, few estates, even those whose resources are best developed, on which such a systematic investigation of the superficial deposits and of the mineral character of the substrata, would not bring to light some hitherto neglected mineral manure, or some bed of stone, clay, brick-earth, or gravel, having an economical value which would repay many times over the trifling expense which would be incurred by such a survey.

Wilmington, near Dartford,
Nov. 1, 1852.

Postscript.

SINCE the preceding pages were in the press, Lord Berners has kindly furnished me with an account of the total cost of draining 398¾ acres. The expenditure for labour appears, by this account, to have been 632*l.* For this sum there were cut 103,981 yards of drains, of various depths, in the following proportions :—

	Yards.
3-feet drains	23,678
3½ „	23,812
4 „	43,579
4½ „	642
5½ „	192
6 „	354
7 „	240
1½ „	11,484
	103,981

This gives 311,943 pipes of a foot long, which may be called, for round numbers, 312,000. Having no data from which to ascertain the proportions of 1½ and 3-inch pipes used, I assume half of them to have been 3-inch pipes, which must be considerably above the truth, and therefore unfavourable to the Keythorpe system.

The following will then be the cost of the draining of these $398\frac{3}{4}$ acres :—

	£.	s.	d.	£.	s.	d.
Labour				632	0	0
Pipes—156,000 $1\frac{1}{2}$ inch, at 16*s*. . .	124	16	0			
„ 156,000 3-inch, at 35*s*. . .	273	0	0			
				397	16	0
				£1029	16	0

Comparing this with the equidistant and up-and-down system, labour and materials being charged at the same prices as before, we have

	£.	s.	d.	£.	s.	d.
At 8-yard intervals, 110 perches of drain, at $6\frac{1}{4}$*d*.				2	17	3
4 perches of mains, at 1*s*.				0	4	0
				3	1	3
Pipes—1815 $1\frac{1}{2}$ inch, at 16*s*.	1	9	0			
„ 66 3-inch, at 35*s*.	0	2	3			
				1	11	3
				£4	12	6
At intervals of 10 yards we have 88 perches of drains, at $6\frac{1}{4}$*d*.				2	5	10
4 perches of mains, at 1*s*.				0	4	0
				2	9	10
Pipes—1452, at 16*s*.	1	3	2			
„ 66, at 35*s*.	0	2	3			
				1	5	5
				£3	15	3

	£.	s.	d.
The cost of draining $398\frac{3}{4}$ acres on the equidistant system, with intervals of 8 yards, at 4*l*. 12*s*. 6*d*. an acre, will be .	1844	4	4
The cost on the Keythorpe system will be	1029	16	0
Saving	814	8	4
The cost of draining with intervals of 10 yards, at 3*l*. 15*s*. 3*d*. an acre, will be	1500	5	11
The cost on the Keythorpe system will be	1029	16	0
Saving	470	9	11
The average cost of the equidistant system, half of the drains being at intervals of 8 yards, and half at intervals of 10 yards, will be	1672	5	1
The cost of the Keythorpe system will be	1029	16	0
Saving	642	9	1

During a recent visit to Keythorpe I saw a hole full of water within three yards of the end of a drain, for no other reason than that there was a ridge of clay between them. It is evident, therefore, that a drain laid in this ridge, or parallel to it, would have been inefficient at even less than half the smallest interval usually considered sufficiently narrow for soils of this description under the equidistant system.

VIII.—*On the Hereditary Diseases of Horses.* By Finlay Dun, Jun., V.S., Lecturer on Materia Medica, &c., at the Edinburgh Veterinary College.

Prize Essay.

Our everyday experience of the production and development of plants and animals at once suggests the existence of the great natural law embodied in the familiar saying, "like produces like." In accordance with this law the peculiar properties, characters, and qualities of the parent—whether good or bad, healthy or diseased, external or internal—are transmitted to the offspring, or, in a word, are hereditary. To illustrate this natural law of hereditary transmission, with especial reference to the diseases of horses and cattle, is the object of this report, and, in treating of the subject, we shall notice—

I. General hereditary characters, both healthy and diseased.
II. The hereditary diseases of horses.
III. The hereditary diseases of cattle.

I. Many interesting and valuable facts have been recorded which prove, beyond all doubt, the hereditary tendency of many of the physical, mental, and moral qualities of man. Parents transmit to their children their own—or, at all events, similar—external forms, similar intellectual capacities, temperaments, dispositions, virtues, and vices, as well as similar tendencies to particular diseases. Certain families are remarkable, during many centuries, for tall and handsome figures, and for a striking similarity of features; whilst others perpetuate a less perfect form, the peculiar deformities of the parents reappearing in the children of each successive generation. For example, the thick upper lip of the members of the imperial house of Austria has been a characteristic of the family for centuries; and every one is familiar with the curious case of the Yorkshire family with their six fingers and toes, which remarkable conformation has continued for several generations; and other analogous cases are recorded.* But the hereditary transmission of external form is exemplified, on a more extended scale, by the striking resemblance often observed amongst the different individuals of a community or race, even where these are exposed to different external agencies. The cases of the Jews and the Gipsies will suggest

* 'Researches into the Physical History of Mankind,' by James C. Prichard, 3rd edition, pp. 244-5. See also, at pp. 347-9, the description of a man whose skin was greatly thickened and covered with warty excrescences, and in whose descendants these peculiarities were noticeable in the third generation.

themselves to every one as most apposite examples. Although exposed for centuries to the powerfully modifying influences of external circumstances of climate, country, association with nations of very different customs and habits, these remarkable races still retain their identity, and remain distinct and peculiar people. But it is not alone their face or figure that remains unaltered, their manners, habits, and customs are also uniform and permanent: a most striking proof of the hereditary transmission of almost every bodily and mental character and quality.

As regards intellectual ability, it is observed that certain races are remarkable for intelligence and aptitude in the acquirement of knowledge, and others for stupidity and narrowness of capacity; that the children of such races, although reared and educated with equal care, always show much difference in intellectual attainments; and that it is only after educating several generations of the less-gifted race that they attain the natural capacity of the more gifted. Both ancient and modern history afford many striking instances of analogous temperaments and dispositions being transmitted from father to son through many generations; of some families remarkable during centuries for virtue, honour, and liberality, and of others notorious during an equally long period for every sort of wickedness, vice, and oppression.

But diseases, as well as physical and mental qualities, descend from parent to children. Many of the most wide-spread and fatal maladies affecting the human subject are hereditary. Under this category we may include pulmonary consumption, which destroys so many of the inhabitants of these islands, frequently decimating, and sometimes completely sweeping away, entire families; scrofula, gout, gravel, and rheumatism, which, like consumption, occur chiefly in predisposed subjects, and in the progeny of those who have themselves suffered from them; most nervous diseases, especially palsy, epilepsy, and insanity, which rarely attack any individual without also affecting many of the same family; and many imperfections of the external senses, as deafness and blindness. These are the most common hereditary diseases incident to man; most of them have their analogues in the lower animals, in which they are also hereditary.

Amongst horses and cattle we find, as in the human subject, ample illustration of the hereditary tendency of external form, disposition, habit, and disease. The parent transfers to its offspring size, shape, and general conformation similar to its own; and the aphorism "like produces like" is as applicable to faulty and disproportioned as to beautiful and symmetrical form, to diseased and debilitated as to healthy and vigorous

constitution, to gentle and tractable as to fiery and indomitable disposition. The size, weight, general appearance, expression of countenance, fleetness, and temper of the horse are all hereditary. Many illustrations might be given of particular families being remarkable during several generations for good or bad *points*, as for well or ill-formed head; for high and well-developed, or for low and weak withers; for fine, strong, and well-turned, or for coarse, weak, and ill-formed limbs. Peculiarities of colour often extend through many generations, and are so constant in their transmission as sometimes to form one of the distinctive characteristics of a race. Indeed, most breeds of horses have a prevailing colour, to which there are few exceptions. The heavy horses of Lincolnshire, for example, are generally black; the Cleveland, bay; and the wild horses of the plains of Eastern Siberia, dun. Particular markings, also —as white spots on various parts of the body, stars and blazes on the face, one or more white feet or legs—often continue for many generations peculiar to certain families.

The general constitution of an animal is no less hereditary than the external qualities to which we have just alluded. Some stocks of horses, for example, can sustain with impunity an amount of labour which, in others of the same breed, would cause serious bad effects; and the peculiar action both of medicines, and of morbific causes, is generally observed to be similar in members of the same family. But besides the general constitution of the parents, their special condition at the time of copulation also appears to be to a certain extent transmitted to the offspring; and hence the necessity of selecting for breeding purposes only animals of a strong and healthy constitution, and of using them only when they are in full possession of all their physical energies. For a high state of the physical energies at the time of impregnation is believed to induce a correspondingly great development of physical power in the offspring; and of this we have a curious example in the fact, that the Arabs, before bringing the parents together, give them a short gallop, believing that the spirit and fleetness of the progeny is thereby enhanced. On the other hand, we find that even a slight and temporary debility at the time of copulation exercises a marked deteriorating effect upon the spirit and vigour of the offspring, and it is well known that the stock of old stallions is generally weak and spiritless: "Senes valetudinarii, imbecilles . . . filios vitiosa constitutione gignunt."—*Fernel.*

It must be observed that external circumstances, as diet and temperature, exercise a powerful influence on animal growth and development. With meagre fare and exposure to cold, animals do not reach the average size of their race, and beget stock as

much below average as themselves. In similarly unfavourable circumstances, these again do not reach the size even of their own immediate parents, and procreate a still smaller progeny. Conditions favourable to growth and improvement operate in a similar manner. They improve each individual, and the descendants of each inherit to a greater or less degree the improvements on the parent stock. Animals, then, are altered by circumstances, and transmit to their progeny their altered forms. Thus, after a few generations, the external characters of a breed are often greatly modified, and hence have arisen the permanent varieties of horses and cattle met with in different parts of the kingdom—the tall heavy horse of the Lincolnshire fens, the light, active, but powerful thorough-bred, the small pony of Shetland—and amongst cattle, the short-horned, the Ayrshire, and West Highland breeds, and many others—varieties which have a common origin, but which are now so distinct and permanent that each produces a progeny with its own distinctive characteristics. Thus, even acquired and artificial habits may become hereditary. Certain districts are famous for their trotting horses, and many Irish hunters are remarkable for their peculiar style of leaping. Some years ago the Earls of Morton and Zetland imported from Dongolia, in Upper Egypt, several entire horses, which were remarkable for their high and prancing action. Their progeny, both out of thorough-bred mares and those of the heavier breeds, inherited the action of the sires to such a degree that they had all to be sold as carriage-horses, being unfit for racing, hunting, or almost any other kind of work. Prichard states, in his 'Natural History of Man,'* that the horses bred on the table-lands of the Cordilleras "are carefully taught a peculiar pace, which is a sort of running amble;" after a few generations this pace becomes a natural one, young untrained horses adopting it without compulsion. But what is still more curious is the fact, that, if these domesticated stallions breed with mares of the wild herds which abound in the surrounding plains, they "become the sires of a race to which the ambling pace is natural and requires no teaching." "The hereditary propensities of the offspring of Norwegian ponies," says Mr. T. A. Knight, in a paper read before the Royal Society in 1837, "whether full or half bred, are very singular. Their ancestors have been in the habit of *obeying the voice of their riders*, and not the bridle, and the horsebreakers complain that it is impossible to produce this last habit in the young colts; they are notwithstanding exceedingly docile and obedient when they understand the commands of their master. It is equally difficult to keep them within hedges, owing, per-

* Second Edition, p. 35.

haps, to the unrestrained liberty to which the race may have been accustomed in Norway." *

Much of what has been already stated concerning the hereditary nature of the external conformation and other qualities of the horse is also applicable to cattle. The progeny of a common stock bear a close resemblance to their parents and to each other in general appearance, length of limb, development of chest, shape of carcase, position and size of the udder, adaptation for the dairy, thickness of skin, and length and texture of the hair. In some of the hot provinces of South America there are cattle "noted for an extremely rare and fine fur. . . . The variety is reproduced or descends in the stock." † In the same localities is also found another race with an entirely naked skin, which peculiarity is also hereditary. In our own country, too, there are great differences in the length and texture of the hair of various sorts of cattle—differences which, as in the South American animals, are transmitted to the progeny. The existence or non-existence of horns, their size, shape, and curvatures, are characters the hereditary nature of which is generally admitted. But defects and deformities may also become permanent in a stock. We are informed by a friend that he has seen several cattle with a small portion of skin covered with short hair situated on the eye, just within its outer canthus ; and that this peculiarity had been traced back for five or six generations, and had occurred in every case in exactly the same spot of the right eye.

We have deemed it advisable thus far to consider the hereditary tendencies of external form, of habit, and of constitution, in order to illustrate more fully and satisfactorily the hereditary tendencies of disease, which we shall now proceed to discuss.

Hereditary diseases exhibit certain eminently characteristic phenomena, some of which we shall here enumerate :—

1. They are transmitted by the male as well as by the female parent, and are doubly severe in the offspring of parents both of which have been affected by them.

2. They develop themselves, not only in the immediate progeny of animals affected by them, but also in many subsequent generations.

3. They do not, however, always appear in each generation exactly in the same form. One disease is sometimes substituted for another analogous to it, and this, after some generations, becomes again changed into that to which the breed was originally liable. Thus, stocks of cattle previously subject to phthisis often become affected for several generations with

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* See Prichard's 'Natural History of Man,' 2nd edition, p. 72.

† Prichard's 'Natural History of Man,' 2nd edition, p. 33.

dysentery, to the total exclusion of phthisis, but by and by the dysentery disappears to give place to the phthisis.

4. Hereditary diseases occur to a certain extent independently of external circumstances, appearing under all sorts of management, and being little affected by changes of locality, separation from the diseased stock, or such other causes as modify the production of non-hereditary diseases.

5. They are, however, most certainly and speedily developed in circumstances inimical to general good health, and often occur at certain so-called critical periods of life, when unusual demands on the vital powers take place.

6. They show a striking tendency to modify and absorb into themselves all extraneous diseases. For example, in an animal of a consumptive constitution, pneumonia seldom runs its ordinary course, and, when arrested, often passes into consumption.

7. Hereditary diseases are less effectually treated by ordinary remedies than other diseases. Thus, although an attack of phthisis, rheumatism, or constitutional ophthalmia, may be subdued, and the patient put out of pain and danger, the tendency to the disease will still remain, and be greatly aggravated by each attack.

Hereditary diseases do not necessarily show themselves at birth. In horses and cattle there are only a few which do so. The scrofulous diathesis sometimes presents itself in large collections of pus, which occasionally prove fatal within a few days after birth; and symptoms of hydro-cephalus, rickets, and occasionally rheumatism—all hereditary complaints—are also sometimes found present at that early period. But most hereditary diseases develop themselves only some considerable period after birth, and the inherent tendency may even remain latent during many years. Thus, in man, gout and gravel do not usually develop themselves until after the meridian of life, and in horses and cattle the tendency to consumption, scrofula, and rheumatism may remain dormant for many years. Nay, more; diseases of an undoubtedly hereditary nature may remain latent even for a generation or two, and afterwards re-appear with all their wonted severity: "Silente sæpe morbo in genitore, dum ex ævo derivatur in nepotem;" * and such cases are not of infrequent occurrence, and are certainly not at all incompatible with the hereditary nature of a disease. They may be satisfactorily explained in various ways. The morbid tendency may be so slight as not to interfere with health, or the animal may have been reared in circumstances where the exciting

* Boeraave, Aphor. de Curandis Morbis, 1075.

causes of the disease have been avoided. But in these cases, where a hereditary disease disappears for a generation or two, the tendency to the disease and the conditions in which that tendency consists are still transmitted, as is obvious from the fact, that the disease develops itself in the descendants with all the characters of a hereditary nature. It requires, indeed, many generations, and a careful selection of parents, to eradicate from a stock a hereditary tendency to disease, and, for a considerable time after it has been got rid of in the majority of the progeny, isolated individuals appear, which, in the phraseology of breeders, "call back" to their more remote progenitors, and possess, like them, an unusual tendency to disease.

There are few diseases which invariably owe their development to hereditary causes. Diseases usually regarded as hereditary are sometimes produced accidentally, and without the intervention of any hereditary tendency. Rheumatism, which often owes its existence to an inherent rheumatic diathesis, may be developed in most animals by continued exposure to the ordinary exciting causes of the malady. Specific or deep-seated ophthalmia, although generally dependent on a constitutional predisposition, sometimes destroys the eyesight of animals in whose pedigree no such disease has been known; and even consumption and scrofula—diseases easily traceable in the vast majority of cases to hereditary predisposition—are occasionally developed in previously healthy constitutions by the conjoined agency of bad feeding, cold, and neglect. From this it is obvious that the production of any disease by extraneous causes is not at all incompatible with its being in other cases decidedly hereditary. Such cases as we have just adduced only serve to show that the same disease is not always referable to the same causes, and that causes very different in their nature occasionally produce the same effects.

Diseases accidentally produced during the lifetime of an individual occasionally become hereditary, but not usually so. Blindness produced by injury or ordinary external causes, and roaring produced by phlebitis or even by bronchitis, are seldom hereditary; and it appears as a general rule, admitting, however, of some exceptions, that a local injury or disease produced by accidental causes is not likely to be hereditary, although a generally deteriorated state of health, however produced, is very apt to be so.

There are various maladies which, from their simulating some of the characters of hereditary diseases, have been thought by many to be truly hereditary. Abortion affords an apt illustration of such a mistake. This disorder frequently prevails in a stock for a long series of years, and sometimes even during

several generations. But although corresponding in these respects to many hereditary diseases, it differs essentially from them, inasmuch as it attacks all animals alike when exposed to the same exciting causes, shows no special preference for those bred from a stock in which abortion has been prevalent, does not affect those removed to a distance from the locality in which the disease prevails, and may sometimes be effectually and immediately arrested by a radical change in the system of management. These conditions are quite sufficient to disprove the hereditary nature of abortion; and when such conditions occur in connexion with any other disease, they may be safely accepted as ample evidence of its being produced by external or extraneous circumstances, independently altogether of any hereditary predisposition.

There are some maladies in which it is comparatively easy to trace the connexion between conformation and disease. In the horse certain sorts of limbs notoriously predispose to certain diseases. Thus, bone spavins are most usually seen where there is a disproportion in the size of the limb above and below the hock; curbs, where the os calcis is small and the hock straight; strains of the tendons of the fore-leg, where the limb is round and the tendons and ligaments confined at the knee; and navicular disease, where the chest is narrow and the toes turned out. Amongst horses so formed, these diseases are unusually common, and are developed by causes which would be quite inadequate to produce them in animals of more perfect conformation. But it appears to us that internal and constitutional hereditary diseases also depend upon the altered conformation or texture of the parts specially affected, or upon some disturbance of the relation which should subsist between the different constituents of these parts. This abnormal state of the internal parts is seldom within the limits of our means of observation or investigation, but its existence in animals having a hereditary predisposition to disease cannot, we think, be doubted, as we shall now endeavour to show. The ground of our reasoning rests chiefly on the analogy which subsists in all respects between external and internal parts. The same law which regulates the hereditary transmission of form, texture, and relation of external and visible parts, also operates with equal force in regard to the form, texture, and relations betwixt the components of parts internal, and, it may be, inaccessible to ordinary powers of investigation. Then, if, as we have shown, external hereditary diseases, such as lamenesses, are traceable to external hereditary peculiarities of conformation, we do not think it pushing our analogy too far to assert that, in like manner, internal hereditary diseases must, in great part at least,

depend upon some inherent hereditary peculiarity of the internal parts affected. The following remarks will, we think, tend to support our hypothesis. Particular conditions of the blood often become hereditary, and, if an excess of the red globules of the blood be hereditary, the disease of plethora to which that excess gives rise will also become hereditary. We have a striking example of this in many of the improved breeds of cattle, in which is conjoined a remarkable excess of the red globules of the blood with a highly plethoric habit of body. If the eye be predisposed to deep-seated ophthalmia, a slight exposure to cold, or even an error in diet, will be sufficient to induce the disease. But before an acute attack there is seldom noticeable in the eye any alteration of texture or of function indicating the existence of such a tendency. That such a tendency does, however, exist there can be no doubt, and we think that it must consist in an altered condition of some of the deeply-seated parts of the eye. Our conclusion is, therefore, that every hereditary disease depends upon some hereditary abnormal condition predisposing to that disease. This abnormal condition may be either local or general. It may affect the form, structure, texture, quantitative or qualitative composition either of solids or fluids. It may constitute so powerful a predisponent to disease as speedily to cause impairment of health, or it may be so slight, that without the co-operation of exciting causes it will fail to produce any apparent disturbance of the general health. But animals with such inherent defects are always predisposed to disease. Influences which are harmless in others often produce in them serious and irremediable disease. Thus, ordinary work causes spavins or curbs in horses with badly-formed hocks; a slight exposure to cold brings on phthisis in a cow of consumptive diathesis; simple engorgement of the stomach causes an attack of ophthalmia in a subject predisposed to it. Hence, an animal having a hereditary tendency to disease labours under many disadvantages, and his health, and even his life, are in constant jeopardy. He is always liable to suffer from slight and temporary errors in diet and regimen, and bears about with him from birth an ill-fated inheritance which affords a congenial soil for the reception and development of disease, and is transmitted to his posterity unimpaired in power, and undiminished in extent.

II. *The Hereditary Diseases of Horses.*

In regard to the hereditary diseases of horses we shall consider, first, those of a local nature, afterwards proceeding to those which are more general in their character, and which affect the system as a whole.

Local hereditary diseases are usually simple in their nature,

and consequently their predisposing causes are easily traced, and usually consist in some peculiarity of external form more or less obvious. This observation chiefly applies to several sorts of lameness, which we shall now notice.

Bone Spavin consists in inflammation of the ligamentous and synovial connections of the bones of the hock, and usually of those between the cuneiform medium and metatarsal bone. Effusion occurs, forming an exostosis or bony tumour on the antero-internal part of the hock, attended during its formation with great pain and consequent lameness. Violent and continued exertion, especially when the animal is growing, is the usual immediate cause of this disease. The amount of strain of the parts affected, and the consequent liability to the disease, are always greatest where the width and strength of the limb below the hock are disproportioned to its width and strength above the hock. Horses of such conformation are unusually predisposed to the most troublesome and serious cases of spavin, and hand down to their progeny a similar conformation and predisposition. Other bony deposits besides spavins are also more apt to affect some families than others. This tendency may depend on an endeavour on the part of nature to strengthen a local weakness, as well as on a general disposition to the formation of exostosis—a disposition always more frequent and stronger in the horse than in most other animals.

Curb is a strain of the calcaneo-cuboid, or posterior straight ligament of the hock, causing pain and swelling on the postero-internal part of the joint. Horses most subject to it are those in which the hock is straight and the os calcis short and inclining forwards.

Of all the complaints to which horses are liable there is none more frequent, more troublesome, or more tedious than *strain* of the *back tendons.* It usually consists in rupture of the minute fibres of the tendo perforans, or of the strong *check* ligament attached to it. To repair this injury inflammation is established; effusion soon follows, and occasionally thickening and shortening of the limb. The frequency and severity of this accident might be greatly diminished by breeding only from animals with sound well-formed limbs. The chances of its occurrence are least in horses having well-shaped knees, sufficiently large both in their anterior and lateral aspects, with the tendons prominent from the fetlock upwards—a formation which gives a flat appearance to the limb when viewed from the side. Horses, on the other hand, with round legs and small knees, to which the tendons are tightly bound down, are especially subject to strains, on account of the want of that full prominence of the posterior part of the knee which is found in limbs of a more perfect conformation, and

which gives a mechanical advantage to the tendons passing over it. With the aid of this lever the tendons perform the work required of them with ease and safety: without it, they are apt to suffer from the sudden and violent shocks to which they are subjected, especially when the horse is put to fast work.

Navicular Disease depends upon strain or laceration of the tendo perforans just where it passes over the navicular bone. It causes pain and tenderness of the parts affected, a short, tripping, but cautious gait, a *wiring in* of the heels, and a wasting of the muscles of the shoulder, with all the other well-known symptoms of grogginess. The predisposition to this disease is especially great in horses with narrow chests, upright pasterns, and out-turned toes. Even with average work, horses in which this conformation is decided can scarcely fail to become groggy, for the distance between the point at which the tendo perforans is inserted into the os pedis and that at which it passes over the navicular bone is so short, and the angle it makes so acute, that the tendon acts at a mechanical disadvantage, and is constantly liable to strain. But defects like these rarely occur singly, there usually existing in addition a want of mutual adjustment between other parts of the limb. Navicular disease is, therefore, to a certain extent hereditary, in so far as there are certain forms of limb especially subject to it. A tendency to it exists in several stocks that have come under my own observation; and I am informed by a veterinary friend, Mr. Tuthill, long resident in Ireland, that he knows of the progeny of several Irish horses, in which navicular disease is so common, that they are always looked upon with suspicion, and bring in consequence lower prices than their general appearance would otherwise warrant. The progeny of "Young Musician," for example, a thorough-bred horse, well known in Ireland, and especially in the western counties, all show a great tendency to this disease.

Acute diseases are usually referable to some cause or causes which are often violent in their nature, but operate for a comparatively short time; their special locality may be determined, or their type or intensity modified, by the particular constitution of different animals; they seldom, however, owe their existence to inherent hereditary causes. Chronic diseases, on the other hand, usually result from the continued operation of causes inadequate to induce acute maladies; they often occur as consequences of badly-treated or acute attacks, their development is greatly dependent upon the special constitution of the individual, and many of them are more or less hereditary. No diseases better illustrate this than those affecting the respiratory organs, such as chronic cough, thick-wind, and roaring, all of which are usually hereditary.

Chronic Cough depends on excessive irritability of the mucous membrane of the trachea or bronchii, and often occurs as a consequence of bronchitis. In unfavourable states of the atmosphere it is greatly aggravated, and in all such cases the slightest over-exertion is sufficient to cause a painful, harassing cough. This irritable condition is very apt to be hereditary. A thickened state of the same mucous membrane, inducing thick wind, grunting, and some of the cases considered as broken wind, is also hereditary; and the same obtains with *roaring*, especially that form of it which alone, in strict propriety, is entitled to the name, and which consists in atrophy, or wasting of some of the muscles of the larynx, especially the crico-arytænoideus posticus. In consequence of this wasting, the cartilages of the larynx fall inwards at every inspiration, and the consequent diminution of the passage through which the air passes causes in respiration a peculiar roaring, grating sound. If the ear be applied to the throat of a roarer, there may usually be heard at each inspiration a grating flap, caused by the cartilage falling inwards. It is important to observe that this sound, as also the roaring noise accompanying it, occurs during *in*spiration: for when such a sound occurs during *ex*piration, it indicates a morbid condition of the lower parts of the bronchial tubes. In roaring, the particular *timbre* or quality of the sound varies considerably, according to the amount of the obstruction. Where this is very great, and the diameter of the tube much reduced, a sharp whistling noise is produced; while, if there be less diminution in the calibre of the tube, a deep roaring or grunting noise is observed. Hence whistling is not in all cases, as is generally believed, a less serious, but, on the contrary, is frequently a much more serious, affection than roaring, resulting, as it often does, from an aggravated state of the same morbid condition on which roaring depends. Roaring may be readily detected, even when not very bad, by giving the animal a gallop, which renders the defect apparent by increasing the rapidity and depth of the respirations, or by suddenly threatening to strike the animal, or giving him a smart blow on the ribs, which causes a sigh or deep-drawn inspiration, and thus gives rise to the sound characteristic of the disease. Pressure on the larynx also induces loud and repeated coughing, and in such cases it is observable that each particular cough has a different sound.

Many cases, illustrating the hereditary nature of roaring, might here be cited. The celebrated horse "Outcry" was well known to be a roarer; many of his stock, out of perfectly sound dams, have turned out roarers; and I am informed, on competent authority, that the defect of the sire has, in several in-

stances, been very evident in the third generation. Some time ago, a friend of my own got from Northumberland two young horses of considerable value. Though perfectly sound at the time of purchase, both soon after became roarers: they had been bought from different breeders, but, on inquiry, it was found that both were got by the same sire, and that many more of his progeny had also become affected by the same disease.

But roaring may occur independently of hereditary causes. It is occasionally produced by the presence of tumours in the larynx or trachea; more often by constrained positions of the head and tight reining, and hence frequently occurs in old carriage-horses. It is sometimes met with in crib-biters, from their being made to wear straps buckled too tightly round the throat. It supervenes from bad attacks of bronchitis, especially when of frequent occurrence, and also from phlebitis, being caused in the latter instance by defective nutrition of the muscles of the larynx. But even in cases where roaring is not congenital, but is produced during the lifetime of the animal, and by accidental causes, it may manifest a hereditary tendency. There is, indeed, no accidental defect more commonly transmitted from parent to offspring than that on which roaring depends.

Considerable caution is requisite in judging as to the existence of roaring in stallions of the heavier breeds, for three-fourths of these, when briskly exercised, produce a loud roaring noise, which often occurs without any disease of the larynx, trachea, or any part of the respiratory apparatus. It results from the high spirit and condition in which entire horses are usually kept, from the acute angle at which they generally carry the head, the abundant deposition of cellular tissue and fat about the throat, the comparatively small width between the sides of the lower jaw, the great development of the muscles of the neck, and the thickness of the mucous membrane lining the larynx and contiguous parts. But the noise so produced is somewhat different from that depending upon morbid peculiarities. It is observed during expiration as well as inspiration, and usually disappears when the nose is elevated so as to be placed as much as possible in a line with the neck. When the sound has these distinguishing characters, and occurs in animals of the heavier breeds with well-formed necks and chests, it is not likely to be productive of any bad effects, or to be hereditary. All such sounds occurring in the lighter breeds of horses must, however, be regarded with great suspicion.

There are few diseases in which hereditary tendencies are so manifest as in that variety of deep-seated *ophthalmia*, or inflammation of the eye, recognised by veterinarians under the various

titles of periodic, specific, or constitutional ophthalmia and moon-blindness. In this disease the inflammation involves, to a greater or less degree, all the internal parts of the eye, exhibits a great tendency to effusion of lymph, often attacks only one eye at a time, but, on subsiding in the one first affected, is very apt to appear in the other; always leaves the eye affected dim, weak, and susceptible to a future attack, and is seldom entirely got rid of until blindness of at least one eye has been induced. The symptoms of this disease are usually tolerably well marked. The mucous membrane and its various appendages are inflamed; there is copious secretion of tears, great pain and tenderness, and marked intolerance of light. The cornea becomes opaque and for some time intercepts the view of the parts within. The eye-lids are nearly closed, and the eye-ball within when visible through the cornea soon loses its clear transparency, in consequence of the humours becoming of a muddy yellowish-brown colour from effusion of lymph. Febrile symptoms are present, and are greatly more intense than might be anticipated from the comparatively small size of the part affected. After two or three days there is often a remission in the intensity of the disease, the external parts being less inflamed and the dull muddiness of the cornea and interior gradually diminishing. A recurrence of the acute inflammation, or its transference to the previously sound eye, is always, however, much to be dreaded. Sometimes the eye apparently recovers, and the superficial observer might consider it perfectly healthy, but the more experienced will find, on careful inspection, sufficient evidence that the organ has been the seat of disease, and that there still remains a change of structure which predisposes to subsequent attacks. The eye seems smaller than its fellow, and still remains intolerant of light; the cornea is often dull, the margins of the pupil frequently uneven and ragged, and the movements of the iris impeded by adhesions; the more deep-seated parts have a peculiar leaden appearance, and shreds of lymph may sometimes be observed floating in the aqueous humor, or embedded in the crystalline lens or its capsule: the last condition constituting what is technically called a *cataract*. This may vary much in size, being sometimes a speck scarcely perceptible, and interfering slightly with vision; at other times large, with white lines passing outwards in every direction, and causing nearly total blindness. Eyes having any of these appearances must be regarded as unsound, and specially susceptible of inflammation, which is apt to be excited in them by such causes, as exposure to cold, high feeding, over-work, or debility, and is liable to return again and again, until the animal is totally blind. But before the occurrence of an acute attack it is scarcely

possible, without an examination of its progenitors, to determine positively whether an animal is predisposed to periodic ophthalmia. Horses with small dark eyes, large, coarse heads, and of dull and phlegmatic disposition, are, however, generally considered to be specially subject to the disease. There is seldom any very apparent defect of the eyes, either in structure or function; still it cannot be doubted that there exists in them some peculiarity of conformation or of minute texture differing from health, and which, although generally unobservable, is yet capable, under favouring circumstances, of fostering serious and irremediable disease.

Ample evidence can be adduced in support of the hereditary nature of ophthalmia. Cases of congenital blindness in stock subject to it are recorded. These, however, are rare; but opacities of the cornea and cataracts are not uncommon. The tendency to the disease frequently shows itself before the animal has been stabled or worked; but more commonly, such changes in the mode of life appear to be the immediate cause of the attack. A very large number of the stock of the celebrated Irish horse "Cregan" have become affected by ophthalmia of the worst kind. I am told by a gentleman well acquainted with this stock that the tendency is still decidedly marked even in the fourth and fifth generations, often appearing, and sometimes speedily causing blindness, very early in life, as at two or three years of age, and even before the animals have been exposed to what are considered the ordinary exciting causes of ophthalmia.

Specific ophthalmia affords a good illustration of a malady which, although usually hereditary, is occasionally produced by accidental causes, and to all appearance independently of hereditary tendency; and this two-fold mode of production has given rise to much contrariety of opinion concerning the hereditary nature of the complaint. It is sometimes produced even in its worst form by over-work and injudicious feeding, but such accidental cases are seldom hereditary, for, as we have above remarked, acquired peculiarities are less likely to be hereditary than inherent ones. From this it is obvious, that all blind animals are not at once to be condemned as unfit for getting sound and perfect stock. The cause of their blindness must be inquired into; and when it can be shown that they have lost their sight from accidental causes, and that the stock from which they sprang was free from all diseases of the eyes, they may be safely used for breeding purposes. If, however, on the other hand, the blindness cannot be traced to any adequate extraneous cause, or if the sire or dam, or any other relatives of the animal, be also blind, or affected with cataracts, the animal must be

rejected, as likely to produce stock with weak eyes, and susceptible of that very serious disease, periodic ophthalmia.

Diarrhœa and *Colic* are to a certain extent hereditary, inasmuch as they are very prone to attack horses of particular form and constitution, as those with narrow loins, large flat sides, and of what is generally termed a *washy* appearance. If such animals be overworked, especially soon after being fed, if their food be suddenly changed, or if they be allowed an unusual quantity of fluid, they are almost certain to be attacked either by purging or colic. The tendency to these diseases appears in such cases to depend on a want of adjustment among the different organs of the body; a want of balance amongst the different functions of digestion, circulation, and respiration.

Many farm-horses, as well as others without much breeding, are remarkable for consuming large quantities of food, for soft and flabby muscular systems, and for round limbs containing an unusual proportion of cellular tissue. These characters are notoriously hereditary, of which indubitable evidence is afforded by their existence in many different individuals of the same stock, and their long continuance, even under the best management and most efficient systems of breeding. Such characters indicate proclivity to certain diseases, as swelled legs, weed, and grease. If horses of this description stand long, the circulation of the blood through the limbs is retarded; for, as the contractions of the muscles which materially aid circulation are wanting, the blood in the veins rises with difficulty against its own gravity, while the soft and lax condition of the venous coats, and of the muscles in contact with them, permits the passage of the fluid parts of the blood, giving rise to a serous effusion which is soft and pits on pressure. This anasarcous condition, although troublesome and frequently recurring, is easily removed by friction, exercise, or a little physic, and does not unfit the animal for ordinary work.

But the same conformation and constitution which induce simple swelled legs, also give rise to the more serious affection known as *weed*, or a shot of grease. This consists in a disturbance of the balance which naturally subsists between the waste of the system and the supply of new material to repair that waste. Food is assimilated in larger quantity than the wants of the system require, the chyle so formed accumulates in the absorbent vessels and glands, which become in consequence irritated and inflamed. That part of the absorbent system situate in the hinder extremities is usually the principal seat of the disease. The animal suddenly becomes lame, the inguinal and other glands in the groin become enlarged and very painful, and the swelling and pain gradually extend downwards along the course of the absorbents, whilst the limb becomes a great deal larger than its natural size.

There is, at the same time, a good deal of constitutional fever, with a full and bounding pulse. The swelling of the leg is in the first instance inflammatory, being hot and tender, and the skin over the part affected, hard and tense. Such swellings may by judicious treatment be removed; but, in cases of a chronic character, or where the same limb has been previously affected, lymph is effused, forming hard and nodulous and even diffuse swellings, which often cause lameness by interfering with the motions of the joints or tendons. These indurated swellings must be carefully distinguished from the serous effusions above noticed, which, although giving the animal an unsightly appearance, do not materially impair his usefulness.

Grease consists in a morbid condition of the sebaceous glands of the horse's heels and fetlocks. It occurs in various degrees of intensity; sometimes as a mere scurfy itchiness of the skin about the fetlocks, more commonly of the hind extremities; sometimes attended with much inflammation, causing great heat, pain, and swelling, and an ichorous fœtid discharge; sometimes causing falling off of the hair about the heels, and the formation of deep cracks and fissures; and sometimes becoming so violent and inveterate, as to cause eversion of the sebaceous glands, formation of granulations, and secretion of pus, constituting the loathsome complaint termed *the grapes.* There are few diseases better deserving the epithet of hereditary than grease, and few in which the hereditary nature can be more easily discovered and traced. Almost every practitioner can bring to his recollection cases showing the tendency of this disease to descend from parent to offspring. A friend of mine some years ago purchased a valuable four year-old-entire horse, adapted for agricultural purposes. When bought, he appeared perfectly sound, and his limbs were nearly black, well formed, and fine; within a short time, however, they became thick and greasy. And, although the mares to which he was put were perfectly free from such faults, the progeny have shown, in every case where they can be traced, unmistakeable evidence of their inheriting the greasy diathesis of their sire. They have all been found liable to swelled legs when they stand idle for a few days, most of them have been the subjects of repeated attacks of weed, all are affected, particularly in spring, with scurfiness of the skin of the hind extremities and excessive itchiness, and lose at a very early age their flatness and smoothness of limb. The faults occur to a greater or less degree in all the stock of this horse by many different mares, and are distinctly traceable to the third generation. But, although grease is undoubtedly hereditary, and is therefore readily induced by comparatively simple causes, still it is frequently caused, and is always aggra-

vated, by neglect of cleanliness, and of this there is ample evidence in the fact, that it is most common in foul and badly managed stables, and where no pains are taken to keep the horses' feet and legs clean and dry.

Inflammation is of two sorts, common and specific. These differ from each other in their symptoms, their progress, and their termination. Common inflammation is accompanied by effusion of lymph and suppuration, has usually a particular seat or locality, is tolerably regular in its course, and tends to a healthy termination: none are exempt from its attacks, and it is seldom hereditary. It is exemplified in the healing of wounds, and in the so-called phlegmasæ, as pneumonia and pleurisy. Special or specific inflammation, on the other hand, has peculiar symptoms, is not necessarily localised, but may affect more or less the whole system, is very variable in its course, not easily subdued by remedial measures, and seldom entirely cured; not easily produced in healthy subjects by extraneous causes, but producible by inoculation, occurring in animals of certain constitution, and owing its development in great part to hereditary predisposition. There are three subdivisions of specific inflammation—the rheumatic, occurring in the various sorts of rheumatism, and nearly allied to it, the gouty, which, however, is peculiar to man; the scrofulous or strumous, occurring in pulmonary consumption; and the syphylitic, also peculiar to man, but occurring in the horse in the form of glanders. In the horse the two latter diatheses are more intimately connected than in man, and often concur.

Rheumatism is neither so common, nor are its symptoms so well marked, in horses as in cattle. When, however, it does occur in the horse, it manifests the same well-known appearances which characterise it in all animals. It affects the fibrous tissues of joints, the coverings of muscles, tendons, and ligaments, and the valves about the heart and larger vessels, and manifests a peculiar tendency to shift from one part of the body to another, often affecting in succession all the larger joints, at one time chiefly located in the neck, and at another in the back and loins, while in many of its more acute attacks it appears to involve almost every portion of fibrous and fibro-serous tissue throughout the body. In all its varied types it exhibits a full, strong, hard, and unyielding pulse, caused by the inflammation involving the serous and fibro-serous tissues of the heart and circulating vessels. During its existence various excrementitious matters accumulate in the blood, and its fibrinous constituents are found to exceed their normal proportions, as indicated by the production of the buffy coat on the blood. In severe or badly-treated cases the inflammation is very apt to be transferred from

the joints and muscles to the heart and its investing membrane, and it is the danger of this change in the seat of the disease that renders rheumatism so formidable, and often so fatal. It always leaves the parts affected so altered as to be extremely predisposed to subsequent attacks; and it is more than probable that this altered condition is reproduced in the progeny of rheumatic subjects, and constitutes in them the inherent tendency to the disease.

Horses sometimes suffer from rheumatic inflammation in the fibrous sheathing envelopes of the muscles of the neck, constituting what is popularly known as *the chords.* When thus affected the animal is very stiff, remains as much as possible in one position, and is unwilling to bend his neck either to one side or another, or to elevate or depress his head. There is always more or less fever, with a strong full pulse. Sometimes, as in lumbago in the human subject, it affects the muscles of the back and loins, causing stiffness, tenderness, and pain, which are especially evinced on moving or turning the animal. These rheumatic affections are very readily produced in predisposed subjects by exposure to rain and cold, especially when accompanied by over-heating or exhaustion. Rheumatism sometimes occurs in horses as a prominent symptom of that epizoötic affection which usually receives the much-abused title of influenza. In such cases the rheumatism is of a somewhat more sub-acute or chronic character than common, and is accompanied by that low debilitating fever so often the concomitant of epizoötic maladies. It usually affects all parts of the body susceptible of the rheumatic inflammation, is attended particularly by those symptoms which indicate disease of the heart and pericardium, as an irregular intermittent pulse, and often terminates fatally by effusions into the pleuræ or pericardium, thus causing death by arresting the motions of the heart. As we shall have again to notice rheumatic diseases when speaking of cattle, we leave the subject for the present, and proceed to the scrofulous or strumous inflammation.

The *scrofulous diathesis,* or constitution, is not uncommon amongst horses. It assumes many degrees of intensity, and predisposes to many diseases. It is most apt to discover itself in horses with narrow chests, large flat sides, weak loins, soft flabby muscular systems, soft thin skins, fine silky hair, large badly-proportioned limbs, and large weak joints, and in those in which digestion is often impaired, excretion irregular, and circulation weak and easily accelerated. In an animal affected by scrofula the blood is in an abnormal condition. There is an alteration in the relative quantity and quality of its various constituents, consisting chiefly in a diminution of the red corpuscules, and an

excess of fibrine, which is besides in a less elaborated state than usual; tubercular deposits are also found in various parts of the body. This alteration in the healthy quantity and quality of the albuminous ingredients of the blood, and in the integrity of the various tissues, is transmitted from the parent to the offspring; and, in proportion to the amount of deviation from the normal state, constitutes a scrofulous diathesis more or less decided. The diathesis is strikingly hereditary,* often affecting many individuals of the same family, often traceable through many generations, and sometimes ascribable to the sire, sometimes to the dam. It is always, however, greatly aggravated (and may be developed *de novo*) by circumstances prejudicial to health—by insufficient food, by exposure to damp and to low temperatures, and, in a marked degree, by "breeding in-and-in." By this system of breeding, any inherent tendency to disease, however slight, is greatly aggravated, and always in a rapidly accelerating ratio in each succeeding generation so long as the faulty system is continued.

The scrofulous diathesis affects various parts of the body, and assumes different forms in different animals, and at different ages in the same animal. It develops itself as rickets, hydrocephalus, tabes mesenterica, and pulmonary consumption, and in these, and all its other forms, is alike hereditary.

Rickets, like the other diseases indicative of a scrofulous habit, depends on malnutrition. The bones are defective in earthy constituents, and consequently give way under the weight which they ought to sustain, becoming bent and deformed. Amongst our patients, however, rickets is neither so common nor so serious as in the human subject, and the young animals affected by this complaint generally gain strength and vigour if they get a sufficiently nutritive diet, and are otherwise carefully tended.

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* Dr. Watson, in his admirable 'Lectures on the Principles and Practice of Physic,' thus speaks of the hereditary nature of this affection:—"In a former lecture," says he, "I mentioned scrofula as one of those distempers the hereditary tendency to which is indisputable. The scrofulous *diathesis* is hereditary: and sometimes scrofulous *disease* is so too. I have seen lungs, taken from the body of a fœtus, stuffed with tubercles. There were some fine examples of this in Mr. Langstaff's museum, in the city. We have, therefore, in respect to scrofula, the rare conjunction of congenital disease, and hereditary disposition. . . . . No one, of the least observation, can doubt that the disposition to consumption is very often transmitted from parent to child. We see whole families swept away by its ravages. Like other hereditary tendencies, it may skip over one or two generations, and re-appear in the next, just as family likenesses are known to do. There are other families in which you can trace no such predisposition; but such families are perhaps few. A little leaven is sufficient, sometimes, effectually to taint a whole pedigree. The tendency, however, exists in various degrees. It may be so strong that no care, no favourable combination of circumstances, will prevent its local manifestation; and it may be so faint that it would never break out into actual mischief if the exciting causes of scrofulous disease could be warded off."—Lect. xii., vol. i., p. 203.

Hydrocephalus, or water in the head, in one of its forms, is a tuberculous inflammation of the internal serous membranes of the brain. It is ushered in by languor, disordered digestion, irregularity of the bowels, and a falling off in condition. The limbs become weak and tottering; the head is hot and tender, and held in a dependent position; the eyes are impatient of light, and the pupils partially closed; there is more or less fever and an accelerated pulse. These symptoms, indicative of active inflammation, give way, after a variable time, to others significant of effusion and pressure on the brain. All the external perceptions become blunted, and the pulse is slow. As the fluid accumulates, the head enlarges, and the bones become soft and thin. This state of depression usually continues until death. The disease is one of early life; it is rarely met with in animals of more than six months or a year old. As has been already remarked, it is sometimes congenital, and, in such cases, there is usually a great increase in the size of the head, from the amount of the effusion and the soft, yielding nature of the cranial bones. The substance of the brain is found, on examination, to be expanded by the contained fluid, and soft and infiltrated with a thin serosity. The membranes of the brain are much inflamed, coated with lymph, and studded with granules and tubercles, which are also found in other parts of the body, especially in the mesenteric glands, and are in all respects identical with those found in the lungs of consumptive patients. These facts establish the scrofulous nature of the disease, and its close connexion with consumption.

Tabes Mesenterica is more common in foals than is generally supposed: it occurs at various ages, but seldom affects animals more than two years old. The matter of tubercle is deposited in the mesenteric glands; and this, interfering with their functions and preventing the due elaboration of the chyle, speedily causes derangement of digestion, imperfect assimilation, and consequently rapid wasting and death from inanition. Apparent recoveries occasionally take place, the tubercular matter becoming cheesy, hard, and gritty; but as the lungs also are usually diseased, recovery is often only temporary, and the animal by and by dies either of phthisis pulmonalis, or of glanders.

We have noticed that variety of consumption affecting the limbs, or rickets; that variety affecting the contents of the cranial cavity, or hydrocephalus; that variety affecting the abdominal cavity, or tabes mesenterica; and have now to notice that variety, perhaps, of all the most common and fatal, and which has its seat in the lungs; this is pulmonary consumption, or *phthisis pulmonalis.* It consists in a deposition of tubercular

matter in the lungs; at first soft and cheesy, or gluey and fibrinous, and becoming, after a time, hard and gritty, but always unorganisable. Its symptoms are irritation of the mucous lining of the bronchia and lungs, as evidenced by cough; occasional febrile symptoms, wasting, and debility, which, in bad cases, sets in early, and is so excessive as speedily to destroy life. We have treated very briefly of tabes mesenterica and of consumption in horses, because we shall have to return to them when speaking of the hereditary diseases of cattle, in which they are more common than in the horse.

These are the most common forms in which a scrofulous diathesis shows itself, but there are other irregular forms which it also sometimes assumes. In early life especially, we recognise it in intractable swellings of the joints, from unhealthy inflammation of their synovial fringes, and in accumulations of pus in various parts of the body. These two forms are often met with in different individuals of the same stock, and are always notoriously hereditary. I know at present of two entire horses, both of fine symmetry and apparently sound and vigorous health and constitution, that have for several seasons got stock, many of which have died within a short time after birth from these complaints, and others have long continued sick and ailing. A pony, in sound health, and which had previously reared a strong and vigorous foal, got by another sire, had a foal to one of these horses. From birth it was weak on its legs, and died before it was three weeks old: an immense accumulation of pus was found underneath the psoae muscles, and all the larger joints were inflamed, especially the stifle joints. In the succeeding year the same pony had another foal to the same horse, which again showed similar symptoms, and died about the same time after birth. Again, in the next year the pony was put to another horse, and had a foal which remained perfectly free from disease. This case, we think, distinctly proves the transmission by the sire of a scrofulous diathesis. The disease of the foals could not depend upon accidental circumstances, for a similar affection occurred in many of the stock got for several seasons by the same horse. The disease was in this instance ascribable to the sire, and not to the dam,—which is obvious from the fact, that the same mare produced and reared a healthy foal both before and after she had the two diseased ones. This last observation must not, however, be misconstrued, as leading to the belief that diseases are inherited from the male alone; on the contrary, form, disposition, and tendency to disease, all depend quite as often on the mother as on the sire.

But a scrofulous diathesis, besides appearing in the forms

above noticed, also constitutes a powerful predisposition to many diseases. In scrofulous subjects sore shins often occur—a complaint common in many racing studs, appearing chiefly in young and rapidly-growing animals, depending on the excessive exertions to which they are subjected in training, consisting of inflammation of the periosteum investing the cannon bones, especially of the hind limbs, and, when neglected, often running on to caries and necrosis.

From their weak and unsound constitution, horses of a scrofulous diathesis are unusally prone to *glanders and farcy*—two forms of a disease peculiar (at least as an original disease) to the equine species. As has been already remarked, it is characterised by a specific unhealthy inflammation, identical in all important characters with the syphilitic inflammation in man. From the dire and loathsome nature of glanders, and the terror in which it is held, animals affected by it are never used for breeding, so that we have little opportunity of judging of its hereditary nature. There is no evidence (so far as I know) which proves it to be directly hereditary,* but there is no doubt that the progeny of a glanderous horse would exhibit an unusually strong tendency to the disease. Its ordinary predisposing causes are, many of them, hereditary: it is very prone to attack animals of a weak or vitiated constitution. It is emphatically *the* disease which cuts off all horses that have had their vital energies reduced below the healthy standard, either by inherent or acquired causes. Glanders is also sometimes caused by inoculation; is frequently produced in healthy subjects by mismanagement, as by insufficient food, want of shelter, and overwork; and often supervenes on bad attacks of influenza, strangles, diabetes, and other diseases which debilitate the system, or impair the integrity of any of its more important parts. These causes appear to possess the power of engendering in the constitution of the horse a peculiar poison, which, as it reproduces itself, and spreads to all parts of the body, gives rise to the characteristic symptoms of glanders, causing, sooner or later, a breaking up of the system, and a fatal prostration of the vital powers. This poison produces in the blood abnormal changes, which vitiate that fluid, and unfit it for healthy nutrition.† From the irritant action of the morbid fluids passing through them, the lymphatic glands and

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* Though I am not aware of any facts proving glanders to be congenital, yet I think there is every probability that such is the case; for it is notorious that syphilis, the analogous disease in the human subject, is congenital, and often appears at birth in the children of women affected by that disease.

† A comparison of the two subjoined analyses will show the great difference in composition between the blood of healthy and of glanderous horses—a difference

vessels become inflamed, and lymph is deposited. This, however, being of an unhealthy nature, soon runs on to softening, which extends to the skin overlying the part, and ulcerating farcy-buds are formed. On the surface of the more vascular mucous membranes effusions of tubercular matter are also poured out; these take on an unhealthy inflammation, and degenerate into chancrous ulcers, which may generally be seen on the mucous membrane of the nostrils in most bad cases of glanders.

These are the most common scrofulous diseases of horses; but an animal of the scrofulous diathesis, besides being specially subject to these, is little able to withstand ordinary morbific causes, and hence is also unusually liable to many ordinary diseases; in such a subject, too, disease is very apt to be severe and complicated, and to be acted on tardily and imperfectly by all remedies.

[*Papers by the same author, on the hereditary diseases of cattle and pigs, will appear in future numbers of the Journal.*]

IX.—*Report upon the Rye and Derwent Drainage.* By John Henderson.

To Mr. Pusey.

Sir,—It affords me great pleasure to comply with your request to furnish the readers of the Society's Journal with a report upon the proceedings of the Commissioners of the Rye and Derwent Drainage.

Natural causes during the present unusually wet season seem to give additional weight to the deductions of scientific agriculture, in urging the attention of the public to the subject of *District Drainage*, at a time when our valleys are converted into lakes, our drains choked up, and the land so injuriously saturated with moisture that it is impossible to exaggerate the importance of the subject, or calculate the enormous damage which has been done by a few weeks of very rainy weather.

It is admitted by all that the first principle of agriculture is the thorough drainage of the land, and the first requisite of

consisting chiefly in a diminution of the red corpuscules, and a proportional increase of the fibrine and albumen:—

	Blood of Healthy Horse.	Blood of Glanderous Horse. A.	B.
Water	804·75	842·	859·
Fibrine	2·41	6·60	8·7
Blood corpuscules	117·13	68·20	44·20
Fat	1·31	76·70	82·27
Albumen	67·85		
Soluble salts	6·82	6·50	5·38

Simon's Animal Chemistry, by Dr. Day, vol. i. pp. 346-7.

thorough drainage a sufficient outfall. The farmer may design deep drainage—the sanitary reformer attempt to remove miasmata—the machine may pour out its countless pipes and tiles—and national loans may contribute to putting them into the ground, but all is of little use unless you previously procure a sufficient outfall.

The rivers, and their tributary streams, are the natural drainage of a country, and it is to the condition and improvement of these,—the great arteries of drainage,—that I am anxious to draw public attention, even in districts where it is supposed, at first sight, that no improvement in outfall is required. In fenny districts, the *difficulty* of drainage has long since stimulated the attention of the owners of land in these districts, and *art* has accomplished with much success what nature, in the greater number of valley formations, will herself perform if unfettered by those artificial obstructions which the necessities of former times, and varied circumstances, have interposed. Generally speaking a river or stream will preserve for itself, if left intact, a sufficient fall for the discharge of its waters, and carry on an efficient drainage of a district or valley, just in proportion to the tenacity of the soil and the elevation of the basin of the valley above the high-tide level of the sea. But, unfortunately, in long settled and densely populated countries like "Old England," there are few rivers, or even streams, that retain at this day their natural features, but, either for the sake of water-power for mills, or head-water for navigation, they have been dammed up above their primitive levels, and the natural drainage of the district interrupted or entirely destroyed.

When our Saxon forefathers founded our villages, and the feudal mill rose upon the banks of our rivers, the plough required but little scope for its industry, and the flat and fertile water valleys were depastured by their cattle,—the forest supplied the fuel of their hearth, and the domestic quern or the rude water-mill prepared their grain,—the want of roads localized their wants and limited their sympathies. But the spirit of the nineteenth century has other requirements. A redundant population cannot spare one acre of land suitable for human industry, and "unrestricted competition" cannot afford to neglect the combined advantages of nature and art;—the earth yields her "black diamonds" alike for the furnace and the domestic fire, and steam and the rail, with impartial energy, distribute them far and wide; the rude mill has given place to wonderful and infinitely applicable machinery, and water-power is well nigh superseded by that of steam. It is time, therefore, that the landed proprietor and the farmer should turn their attention to the condition of their rivers and streams, with the view of restoring to them their natural

and primitive function as arteries of drainage, by the removal of obstructions from whatever cause existing.

It is an old saying, "What is everybody's business is nobody's," and the operations of district drainage are extensive, and seldom come within the power of an individual to effect: hence it too frequently happens that works of great public utility are unattempted, for want of that combination of interest and intensity of purpose, which is necessary to secure general co-operation and ultimate success. It is under the special authority of Parliament *only* that extensive works of this description can be undertaken; until some general drainage act, to be carried out according to the designs and under the inspection of competent commissioners, be framed and passed, in order to avoid the expense of individual or special application, and to facilitate those improvements of property, which both the science of agriculture and *public health* so imperatively demand. How many extensive and fertile valleys are there, the drainage of which is confined entirely to sluggish meandering streams upon which, at every few feet of fall, there stands a corn-mill of perhaps only a few horses'-power, the total value of which, in fee simple, is not worth as much as the amount of the damage which is occasionally done by a single flood, letting alone the permanent injury which is occasioned by the damming up of the outfall, in preventing the proper drainage of the surrounding land; and if even the outfall of the drains were, in certain cases, proposed to be carried below the mill-dams, it would, in many instances, require the co-operation, possibly, of several proprietors to effect it. Let any one travel from the Tyne to the Bristol Channel, down the rich red sandstone valleys, and observe the condition of the streams as to drainage, and he will have scope enough for his imagination in depicting the benefits which would result if all the mill-dams and artificial obstructions were removed, and the waters were allowed to regain the level of their natural outfall.

The district which has been the scene of the operations of the Rye and Derwent Drainage Commission, the proceedings of which I am about to detail, is one amongst many hundreds, where all the evils of obstructed outfall were demonstrable, and yet where all the benefits of improved drainage were, to a great extent, attainable, simply by the removal of artificial obstructions, such as dams, locks, waths, &c., from its rivers; and it offers so good an instance of both the requirements and the benefits of *District Drainage*, that I shall be excused offering such a description of the locality, as may enable others to judge and compare whether the operations of this Commission may be applicable to other districts in which they may be interested.

In the North Riding of Yorkshire is the valley, or rather wide

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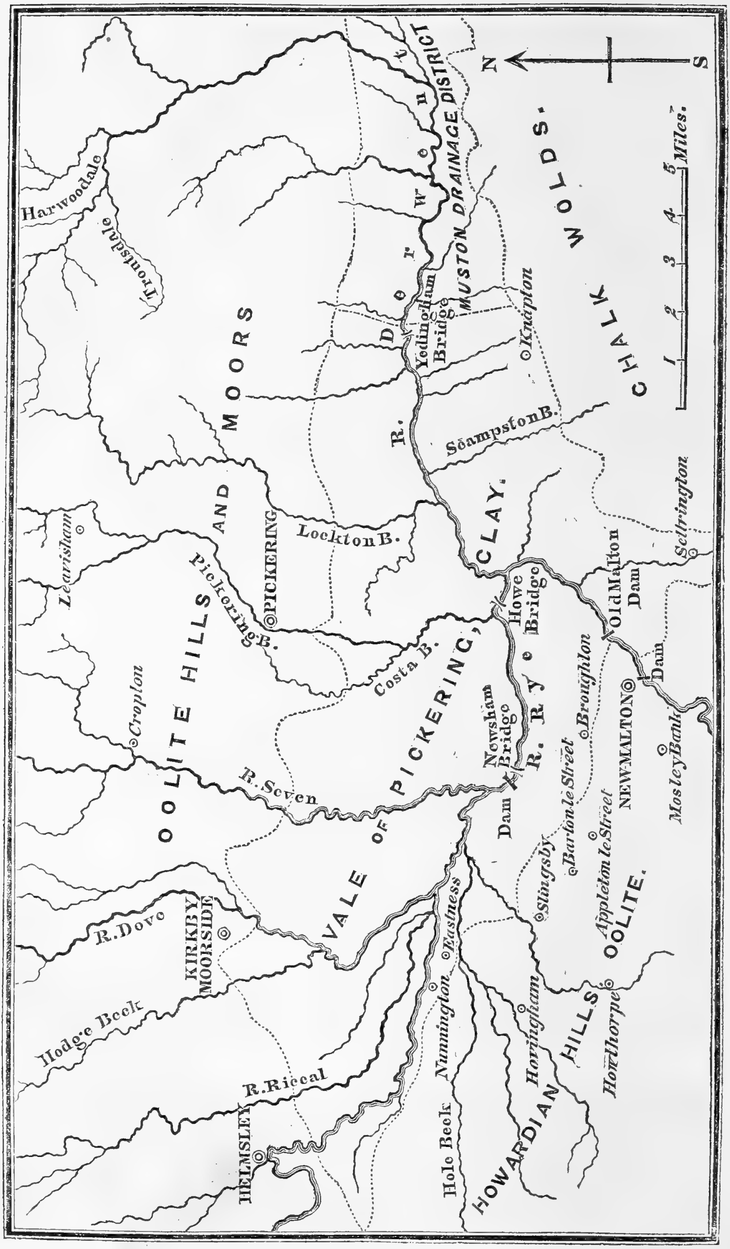
N
S
Miles.
1 2 3 4 5
R. Derwent
MUSTON DRAINAGE DISTRICT
CHALK WOLDS.
Yedingham Bridge
Knapton
Scampston B.
Sellrington
Old Malton Dam
Dam
NEW MALTON
Mosley Bank
Broughton
Barton le Street
Appleton le Street
Slingsby
OOLITE.
Hovingham
Howthorpe
HOWARDIAN HILLS
Hole Beck
Nunnington
Eastness
CLAY.
Howe Bridge
R. Rye
Newsham Bridge
Dam
VALE OF PICKERING,
Costa B.
Lockton B.
PICKERING
Pickering B.
MOORS
AND
OOLITE HILLS
Harwoodale
Troutsdale
Levisham
Cropton
R. Seven
R. Dove
KIRKBY MOORSIDE
Hodge Beck
R. Riccal
HELMSLEY

level, called the Vale of Pickering, in length about 25 miles and in breadth about 8 miles, and containing an area of not less than 160 square miles.* It consists of a clay vale formation, technically called the "Kimmeridge clay." Its general structure is a thin alluvial covering, and a variable thickness of diluvial pebbles and clay upon a bed of thick blue clay. It is bounded on the north by the Yorkshire Moorlands, the basis of which is oolite limestone, dipping to the south, and upon which the clay vale formation lies, and on the south by the Yorkshire wolds of chalk, under which the valley clay runs, and towards the west by the Howardian hills of oolite. These ranges of hills meet together, or nearly so, at the east end, near Filey on the coast; and at the west end, near Helmsley, the hills also meet together and equally close the valley in that direction. The only outlet for the drainage of this wide plain is at Malton, on its south side, and nearly equidistant from its extremities, and, fortunately, towards this point the substratum of clay, which forms the basis of the valley from the north, east, and west, somewhat inclines in a basin form. The natural drainage is carried on by the rivers Rye and Derwent, which both arise at the summit of the moorlands, at the opposite ends of the valley, and run a course of not less than 40 miles, each receiving many large tributary streams, descending from the moorland dales, which open into the main valley. About three miles above Malton, very nearly in the centre of the vale, the Rye and Old Derwent unite and become one river; the Derwent, which runs in a south-west direction, and, passing through a ravine of dislocation through the oolite rocks at Kirkham, gains the vale of York, discharging its waters into the Ouse, meeting the tide-water of the Humber at a distance of about 27 miles below Malton. The general level of the valley is about 60 feet above the sea, and the lowest level at Yeddingham Bridge only about 35 feet; and were this valley at Kirkham closed up, the vale of Pickering would become, what there is little doubt it once was, an extensive lake, discharging its water into the sea at Filey.

The artificial obstructions placed upon these rivers were as follows:—At New Malton, on the Derwent, was a mill mentioned in Doomsday Book; another at Old Malton, a mile higher

* The annexed plan is only intended to represent generally the geological formation of the district—the topography and the number and extent of the rivers and streams; it was desirable also to have represented the *contour* lines of the land *actually flooded and injured;* but it was found impossible, on so small a scale, to reduce the boundaries of the *assessed* lands—they must therefore be imagined to occupy a narrow space spreading generally along the margins of the rivers and streams, extending to the level of 4 feet above the highest flood marks, and in several places, particularly at the confluences of the streams, forming basins of considerable extent.

up the river, dating from about a century later, the two possessing, at the time the dams were removed, a fall of 11 feet. Subsequent demands for water-power had multiplied the number of the mills of one sort or another at Malton drawing their water-power from the same head, to six, computed to possess a power equal to that of about 85 horses. In the reign of Queen Anne, the Derwent was made navigable up to Malton, and, in the beginning of this century, the navigation was extended from Malton to Yeddingham on the Old Derwent, by the erection of locks, &c., at New and Old Malton, which enabled barges of 4 feet draught to go up a distance of about 11 miles towards the east end of the vale. On the river Rye at Newsham (which is distant from Malton by the river above 9 miles) was a mill with a fall of about 6 feet, and the power *used* at this mill was computed at about that of 10 horses, although there was much water that ran to waste.

Such were the obstructions which the wants of former ages, and the necessities of different circumstances, caused to be raised upon these rivers which were then, as now, the only means of drainage of this extensive vale; and it is to be remarked that they principally existed at the worst possible point, where the united river passed as it were the basin of the lake, and entered into the ravine through which all its waters had to flow over a limited and rocky bed. Thus art, for the possession of about seventy-horse power, had erected obstructions upon the river at the point where a beneficent Nature had, in ages long since past, by internal dislocation or external denudation, opened a passage for the discharge of the waters of this primæval lake, leaving a rich alluvium which only requires that art should assist, and not obstruct, the operations of nature, to be—or, perhaps, it may be said already is—one of the most beautiful and fertile vales in England.

This is an instance where the first and great object of attainment obviously was the removal of the dams, locks, and waths or fords, and the straightening of crooked parts of the rivers, and particularly widening the embouchures of the several streams at their junctions with the main rivers; so that the waters might be brought down from the distant moorlands, and passed out of the valley through the ravine at Malton with such rapidity, that in ordinary floods, particularly those of summer, the water may be cleared out of the district before it has had time to pond back; and in the case where the rain has fallen partially, at either the west or the eastern district of the vale, the flood-water of one river have passed the junction before that of the other has come down.

Public attention had frequently been called to the subject of draining this vale. In the year 1800 an Act was obtained for draining its eastern end as far as Yeddingham Bridge, called the

Muston Drainage District. This was effected by turning a portion of the *flood*-water by a sluice and a new cut, from the upper third of the River Derwent directly into the sea, and by a new river or drain from Muston to Yeddingham, draining an area of about 12,000 acres. Several proposals had been made to drain the western and mid portions of the valley from Hovingham and Nunnington to Pickering and Yeddingham, but it was not until the year 1845 that sufficient unanimity could be obtained to take any decided steps for the attainment of this great object. However, in the following year application was made to Parliament, and an Act obtained which incorporated fifty-three parishes and townships in the North and East Ridings into a drainage district, and appointed about seventy Commissioners, who were all either landed proprietors or their agents, with powers to purchase and remove the mills, mill-dams, locks, shoals, &c., and to assess the lands benefited according to the benefit received, or that might be received, in a sum of money not to exceed 30,000*l.*

I shall take leave, in rather minute detail, to give an account of the proceedings of the Commissioners, even at the risk, I fear, of being considered tedious, but in the hope that they may afford some clue for the guidance of others.

In consequence of the heavy rains and of the floods thereby occasioned on the lands adjoining the Rivers Rye and Derwent, and the great injury done thereby to the growing crops in 1845, I was induced for the third time in the course of twenty years, with the approbation of Lord Carlisle, under whose auspices I have acted in any interest I took in carrying out the drainage, to try whether the obstructions in these rivers, caused by three mill-dams (namely, one at New Malton, one at Old Malton, and that at Newsham), might not be removed. My first step was to press Lord Fitzwilliam's agent (Mr. Allen) into the service. He, Lord Carlisle's solicitor, and myself, waited upon a few of the largest proprietors of land embraced in the scheme, who, with very few exceptions, came cordially into the measure we proposed to take, viz., to convene (by issuing circulars) a meeting of all the proprietors of land in the district. Paper 1, with others given in the Appendix, is a copy of the circular, and Paper 2 the result of the meeting. In the Session of 1846, the Act termed 'The Rye and Derwent Drainage Act' was obtained. Among the first steps taken by the Commissioners under the Act was a resolution to advertise for a surveyor or surveyors, to survey, level, and map the whole of the lands which they considered would fall within the limits of the Act. Paper No. 3 is a copy of the specification, &c. &c. The next important step was the appointment of two valuers, with an umpire, into whose hands of course the plans and books of reference were placed, and they

proceeded to inspect the lands, to strike out what they thought not chargeable, and to lay a rate upon such as they considered would be benefited, provided the facilities afforded by the removal of the dams were taken advantage of. Paper No. 4 is a summary of the result of their inspections, and No. 5 will show the mode the valuers adopted in laying the rate. I should have said that, prior to the second inspection by the valuers, the three dams had been purchased and entirely demolished. These are the sum and substance of the whole affair, as far as the Act of Parliament is concerned.

The Commissioners having progressed so far in complying with the provisions of the Act, as to appoint the surveyors, valuers, clerk, treasurer, &c. &c., approached—with a due sense of the difficulty of the subject—the consideration of the best means of ascertaining the value of the water-power existing upon the rivers, as well as of the mill property, which they might be obliged to purchase of its owners. For this purpose a committee of the Commissioners was appointed (of which I had the honour to be a member), with powers to negociate, and, if possible, come to some arrangement with the owners of the property. As the Committee did not feel themselves so conversant in the value of property of this kind as to warrant them in acting upon their own judgment, and the utmost care being necessary in order that they might accomplish as much as possible with the limited sum named in the Act, they sought the aid of persons of competent practical knowledge and experience in such matters; and a most respectable firm in the West Riding was appointed to inspect the premises, to value, and to report their opinion to the Committee.

The following is an abstract of that Report:—

	Horse-power.		Value. £.	Value. £.	s.	d.
No. 1. Newsham Mill-dam (fall of 6 feet):—						
Value of available water-power computed to be equal to	24	=	4320	..		
Site, buildings, wheels, gearing-stones, machinery, ashlar work, &c.	..		..	1147	2	8
No. 2. Old Malton Mill-dam (fall of 4½ feet):—						
Available water-power	33	=	5940	..		
Buildings without the site of mill and the machinery, &c. &c.	..		..	2234	3	9
No. 3. New Malton Mill-dam (fall of 6½ feet):—						
Available water-power	52½	=	9450	..		
Buildings without the site and machinery, &c., of large mill	..		..	1988	0	0
Buildings, machinery, &c., of—						
No. 1 of the small mills	..		..	470	0	0
No. 2 ditto	..		..	420	0	0
No. 3 ditto	..		..	1100	0	0
No. 4 ditto	..		..	400	0	0
	109½	=	19710	7759	6	5

Making a total of available water-power in the three mill-dams equal to that of $109\frac{1}{2}$ horses, valued at 19,710*l.*, and mill property, exclusive of any tenants' rights, valued at 7759*l.* 6*s.* 5*d.*; making a gross sum of 27,469*l.* 6*s.* 5*d.*

The reception of this Report, estimating the value of the property to be purchased at a sum for which, if a fair equivalent had to be paid (as will be afterwards shown), would not only have absorbed *more* than the sum the Commissioners had at their disposal, but would have *exceeded* by nearly 2000*l.* the *entire* sum they were empowered to raise under the Act, threw the Committee into a state of the greatest difficulty; and, of course, it became a question whether they should proceed any further in carrying out the scheme, or abandon it at once, with the loss of the expenses of procuring the Act, and of surveying the district. The Committee, however, were met in such a liberal spirit by the Earl Fitzwilliam (the proprietor of more than four-fifths of the mill property in question) that they resolved to persevere, thinking they were fully justified in attempting a compromise.

As the Committee were not in a position to purchase the entire of this property, they made an offer to the Noble proprietor of the Malton Mills, upon the basis of converting the *actual water-power used* into steam-power, and compensating for the maintenance of the latter power as compared with that of the former.

An investigation was consequently made as to the amount of power *actually used.* At the Old Malton and New Malton mills the available power had been estimated in the valuation at that of $85\frac{1}{2}$ horses, and that at Newsham mill at 24-horse power, making a total of $109\frac{1}{2}$; but the power actually made use of was found not to exceed, in the whole, that of about 70 horses, with the drawback of the loss of several weeks in a year from back water, and occasionally from drought, viz.—

No. 1. Newsham Mill was estimated at	10	horses' actual power.
No. 2. Old Malton Mill . . .	20	"
No. 3. New Malton Mill . . .	20	"
The four small mills at New Malton	20	"
Total . . .	70	

Taking the mills at Old and New Malton, for example, at 20-horse power each, and an equal power used by the small mills, or 60-horse power in the whole, the basis of the calculation became—first, the cost of providing steam-engines of the *number* and *power* used; and secondly, the cost of the fuel and expenses of maintaining these steam-engines, over and above that of the ordinary water-power employed.

To arrive at a satisfactory approximation to these facts, a Sub-Committee was appointed to make the necessary inquiries, and to obtain the best information possible on these points, and the result of their investigations is as follows:—

As the greater part of the water-power was employed on corn and flour mills, upon these the calculations were chiefly based. It was generally admitted to be very near the truth, that to turn a pair of flour-mill stones properly, requires a power equal to that of two and a half horses, or, on an average, twenty horses power, to turn and work a mill of eight pairs of stones. At the period of the inquiry, a very good high-pressure steam-engine of that power could be obtained for 500*l.*, and it was estimated that the necessary buildings, engine-bed, chimney, and the gearing for applying the steam-power, and other alterations in the machinery, would cost an equal sum of 500*l.*; so that the total cost of a 20-horse steam-engine, with all its appliances for the purposes required in this case, would be 1000*l.*, or 50*l.* per horse-power.

It was ascertained from practical men, that a condensing engine would not consume more than from 5 lbs. to 5½ lbs. of best Newcastle coal per horse-power per hour; but as it was determined in this case that high-pressure engines should be adopted, and as coal of that quality had never been used in this neighbourhood for such purposes, the calculations were made for the use of ordinary steam coal, and 10 lbs. per horse-power per hour was generally admitted to be a sufficient allowance. Thus it appeared, that for the supply of a 20-horse high-pressure steam-engine, working 311 days in the year, and 12 hours per diem, the quantity of coal consumed would amount to 333 tons, which, at the price of the day in this neighbourhood—viz. 7*s.* per ton—would amount to 116*l.* 11*s.* 6*d.*

Putting it in the form of an account, the total cost was estimated as under:—

	£.	*s.*	*d.*
Twenty-horse engine, per annum, for coal . . .	116	11	6
Wages of engineer, 21*s.* per week	54	12	0
Wear and tear of engine, tallow, hemp, and oil, taken at 1*l.* per horse-power	20	0	0
	191	3	6—
a sum which, at twenty years' purchase, was equal to .	3,823	10	0

The wear and tear of boilers were considered to be compensated for by the expense of keeping up the mill-dams, &c.

Applying these calculations to the conversion of the whole of the water-power, actually in use, into steam-power, and its maintenance, would cost as follows:—

			£.	s.	d.
No. 1. Newsham Mill	10 horses		1,911	15	0
No. 2. Old Malton Mill	20	,,	3,823	10	0
No. 3. New Malton Mill	20	,,	3,823	10	0
No. 4. Smaller mills	20	,,	3,823	10	0
Total cost of coal, &c., for	70	,,	13,382	5	0
Total cost of engines of 70-horse power, at 50*l.* per horse-power			3,500	0	0
			16,882	5	0

Being an equivalent of 241*l.* 3*s.* 6*d.* per horse-power, for the conversion from water-power to that of steam and its maintenance.

Having proceeded thus far, and ascertained the above elements in the valuation of the power, it remained for the Sub-Committee to attempt an adjustment of the claims as regarded the property in the buildings, gearing, &c., of the mills, which had been valued at 7759*l.*, also as to the value of the upper navigation to Yeddingham Bridge, two fisheries, and the claims for tenants' rights upon the whole.

The mill property, as above stated, was valued at 7759*l.*, but deducting the amount which belonged to the water-wheels, gearing, and other things which had been included in the compensation for conversion into steam—viz. 2187*l.*—left a claim of 5572*l.* against the Commissioners. In two instances the mills had to be entirely demolished, and rebuilt in different situations. There was, therefore, a strong claim for some compensation on that score; and it was ultimately agreed upon that the owners should retain the mill property, upon compensation being given for loss and damage and the removal and rebuilding, which was settled at the sum of 3367*l.* 15*s.*, leaving the owners to alter or rebuild the mills as they thought proper.

The Yeddingham navigation was the property of the noble owner of the six mills at Malton, but the advent of the York and Scarborough Railway had much deteriorated its value. Whatever that might be then, the Sub-Committee did not investigate, as it was evident that the funds at the disposal of the Commission would not allow of any further outlay. There were also the claims for two fisheries, and those for the tenants' damages, which for time lost during the alterations and rebuilding of the mills, and for the derangement of business, could not be inconsiderable; yet the noble proprietor of the whole of this property consented to take all these upon himself, as well as to forego any claim for the loss of the navigation, simply with a view of facilitating the operations of the Commissioners, and enabling them to proceed with the completion of their work, although he could scarcely be said to be interested in the drainage

to any great extent, inasmuch as his own estate had a complete system of drainage effected at his own cost, with its outfall below the lowest of the mill-dams.

The following is a summary of the entire cost of compensation which was agreed to be accepted by the millowners :—

	£.	s.
Cost of steam-engines	3,500	0
The fee-simple of maintaining them . .	13,382	5
Compensation for damage to mills, &c. . .	3,367	15
	20,250	0

Equal to 289*l.* 5*s.* 8*d.* per horse-power.

Such were the terms upon which the Commissioners succeeded in procuring the removal of the three mill-dams.

Having now gone through most of the details of the operations of the Commissioners, and explained the best way I am able the principles upon which the valuation of the water-power and its substitution by steam-power was made, and the mode in which the land was assessed and the money expended, I must, before I conclude this paper, lay before the reader my opinion of the effect which has been produced, and the amount of success which has crowned their efforts; because success is ever more tempting to imitation, than is the enunciation of the truest principles untested by practice, and because there are not wanting those who even deny the benefits so manifestly received if they have to pay for them, though, as the assessments get gradually liquidated, the complainants become fewer and fewer; and I doubt not in the end, that the work of this drainage, which I have endeavoured to describe and to hold out as an example to other districts, will be considered as the very greatest benefit, in an agricultural as well as in a sanitary point of view, which this district of Yorkshire has ever received.

That floods would be altogether obviated was never contemplated or expected even by the most sanguine; but the result has been that when they do occur, they have been very much less both in extent and duration. In fact, two or three days will now run off the highest floods we have; and instead of the country, in the basin of the vale, lying under water the greater part of winter, which when an autumn flood occurred was invariably the case, the water is now within the banks of the rivers in a few hours.

To give your readers some idea of the volume and violence of the floods, to which this vale before the removal of these obstructions of art was subject, I may be allowed a short digression. It happens that the confluence of the two rivers is in the very centre of the vale, at the lowest level of the basin, each running

from an opposite direction a distance of above forty miles. In whichever river the water from the hills comes down the earliest, it had the effect, at the confluence of the two, to drive back the water in the other even *against* the stream for several miles. A whimsical instance occurred a few years ago. A gentleman, who had lost, among other buoyant articles, his brewing utensils in a flood, naturally, when the water subsided, commenced his search for them down the stream, but eventually they were found in the very reverse direction; the volume of back water had floated them a long way *up* the river, and where (as it may be said) at "the turn of the tide," they were left high and dry in the middle of a field.

The Act of Parliament having limited the amount of assessment to a sum not to exceed 30,000*l.*, has prevented the Commissioners carrying out their views to the extent originally contemplated, and from giving all the facilities to the proper under-drainage of the district, which the removal of the mill-dams would have enabled them to have done, if they had had a margin of a few thousand pounds to fall back upon, for the purpose of scouring, straightening, and improving the rivers and streams. I must not omit to mention that the Act provides for the appointment of a water-bailiff, with a salary of not more than 50*l.* per annum, arising from a sum invested in the funds; whose duty it is to inspect the rivers, streams and watercourses, &c., which are enumerated and included in an award made by the valuers, and enforce the due attention to the maintenance of the banks, and the uninterrupted discharge of the waters at all times.

Notwithstanding the limitation which was put upon these operations, yet the benefit which had been received by what has been done is immense, and where the advantages have been taken and the proper means used, a good and efficient drainage has been obtained; and with a little additional outlay, which sooner or later I doubt not will be made, facilities may be afforded for the most perfect and successful mode of pipe and tile drainage to every acre of the district. The proprietors of the several districts abutting on the streams, have already by private contributions done a great deal towards scouring the beds, and removing trees and other obstructions with great benefit, at a very small cost; and in the Old Derwent they have even formed a new river above three miles long, which has shortened the length of the stream about one-third, and has done incalculable benefit, and proposals are made to extend this new cut as far as Yeddingham Bridge.

Not only has the whole of the district embraced within

the limits of the Rye and Derwent Act been benefited, but by the increased outfall an opportunity is afforded, if the new cut be carried forward up to Yeddingham Bridge, of an increased outfall *there* of two feet and a half, to a very important tract lying in the eastern portion of the vale embraced within the limits of the Muston Drainage Act; and in the Rye and Derwent Act powers are given to the Commissioners of the two drainages, to treat for compensation for any increased facilities which might be afforded to the upper district. This has not yet been taken advantage of, although the inducement held out is so manifest.

I may be allowed to say—and I do not think that I say too much when I affirm—that I have known one flood do more damage to crops and tilth, if fairly valued in money, than the whole sum expended under this Act. What the condition of the district would have been just now, after the unprecedented falls of rain we have had, it is impossible to imagine; for although there has been land flooded during these rains, particularly where the banks were imperfect, yet the benefit may in some measure be estimated when I mention, that at New Malton Mill the water has never risen within *five feet* of the former height of a high flood: the consequence is, that there being such a rapid outfall, the lands above, in place of being submerged all the winter, a few days after the rain ceases, are now sufficient to run off all the water, and the effect in some instances to grass land is beneficial, rather than injurious.

In a sanitary point of view, it is impossible to overrate the benefits of this improvement to the climate of the district, during the prevalence of north-east winds, blowing over an extent of so many thousand acres of land, in the marshes which formerly, during the winter months, if not actually under water, remained in a stagnant state, overcharging the air with moisture, and not unfrequently with miasmata, rendering it colder and less genial to the health of man and beast, and very detrimental to vegetable life generally.

I have the honour to be, Sir, yours faithfully,

JOHN HENDERSON.

Castle Howard, December, 1852.

APPENDIX.

No. 1.—Circular to Landowners.

"Sir,—In consequence of the late heavy floods in the valleys of the Rye, the Derwent, and their tributaries, by which many thousand acres of land have been inundated, certain of the proprietors of these lands are directing their attention to the propriety of adopting some measures to prevent the great destruction of property occasioned by a recurrence of the floods in these districts.

"Though it is but a rare occurrence for the waters to rise to a height so considerable as during the present summer, for many years past the lands on the banks of the Rye and Derwent have suffered greatly from inundations; and the annual loss occasioned to the occupants of the farms near these rivers is doubtless many thousand pounds. Independently of the damage occasioned by these floods, the application of tile drainage to much valuable arable land, lying contiguous to the rivers in question, is totally prevented by the back water.

"The injurious effect of the imperfect drainage on the health of the inhabitants in the districts inundated, is a consideration of great importance, and cannot fail to have its due weight both with the owner and occupier.

"When it is considered that this destruction of health and property might be obviated by a comparatively trifling outlay, it appears not a little surprising that year after year has been allowed to pass without some attempt to attain results so desirable.

"The Earl Fitzwilliam, the Earl of Carlisle, Lord Morpeth, and many other of the proprietors, being desirous that some steps should be immediately taken, it is proposed that a meeting shall be called (of which due notice will be given) for the purpose of ascertaining the sentiments of the rest of the land-owners, and for discussing the best mode of securing the end proposed; and we beg to request you will allow your name to be added to those upon the provisional Committee, who will shortly be called together for the purpose of taking the subject into consideration.

"We have been instructed therefore to apply to you for the purpose of requesting your co-operation in a project which must prove so beneficial to your interests.

"We have the honour to be, Sir,
"Your obedient humble Servants,
"Smithson & Jackson,
"*Solicitors.*

"*Malton, 27th August*, 1845.

"*Provisional Committee.*

The Earl Fitzwilliam.
The Earl of Carlisle.
Lord Morpeth.
Sir W. Worsley, Bart.
A. J. B. Creswell, Esq., M.P.
Henry Willoughby, Esq.
John Watson, Esq.
William Allen, Esq.
John Henderson, Esq.
Thomas Varley, Esq.
Mr. Abbey."

No. 2.—Rye and Derwent Drainage.

"At a meeting of the proprietors of lands and others interested in the drainage of the Valleys of the Rye and Derwent, held at Mrs Kimberley's Hotel, New-Malton, on Thursday, the 4th day of September, 1845, present:—

Earl Fitzwilliam.
Lord Morpeth.
Sir W. Worsley, Bart.
Henry Willoughby, Esq.
John Woodall, Esq.
John Scott, Esq.
Mr. Park.
Rev. W. Walker.
Colonel Mitchelson.
Richard Hill, Esq.
W. Allen, Esq.
J. Henderson, Esq.
T. B. Phillips, Esq.
R. Bower, Esq.
W. Gray, Esq.
W.C. Copperthwaite, Esq.
A. Simpson, Esq.
W. Tuke, Esq.
Richard Surr, Esq.
Thomas Walker, Esq.
J. Kendall, Esq.
I. Priestman, Esq.
James Tindall, Esq.
William Tindall, Esq.
J. Newton, Esq.
Thomas Stamper, Esq.
Mr. Hodgson.
Mr. Robert Wise.
Mr. Scott.

"Letters of approval have likewise been received from

LORD FEVERSHAM.
SIR G. STRICKLAND, Bart., M.P.
A. J. B. CRESWELL, Esq.
W. RUTSON, ESQ.
T. BARSTOW, Esq.
G. OSBALDESTON, Esq.
H. J. LESLIE, Esq.
D. W. NELL, Esq.
J. MUNBY, Esq., on behalf of Mr. Stapylton's Estate.
T. VARLEY, Esq., &c. &c.

"LORD MORPETH having been called to the chair,

"It was unanimously resolved—

"1st. That this meeting is of opinion that a more efficient system of draining the Vales of the Rye and Derwent is highly expedient.

"2nd. This meeting being of opinion that the only effectual means of accomplishing the above object is the removal of the mill-dams in the Rye and Derwent, so as to afford the proprietors greater facilities for draining their own lands, Resolved, That steps be immediately taken for the purchase of the mill and water rights, and removal of the dams in the above rivers.

"3rd. That an Act of Parliament be applied for in the next Session.

"4th. That this meeting form itself into a permanent Committee (with power to add to its number) for the purpose of taking the necessary measures for carrying the above resolutions into effect,—and that five be a quorum for transacting business.

"5th. That a sub-committee, consisting of the following gentlemen, be appointed to direct the general business of the project, and to report from time to time to the general Committee:—

WILLIAM ALLEN, Esq.
MR. ABBEY.
W. C. COPPERTHWAITE, Esq.
THOMAS DONKIN, Esq.
JOHN HENDERSON, Esq.
A. SIMPSON, Esq.
MR. STERRIKER.
THOMAS WALKER, Esq.

"6th. That Messrs. Smithson and Jackson, and Messrs. Donner and Woodall, be appointed joint Solicitors."

"(Copy.) No. 3.

"SPECIFICATION for SURVEYING, MAPPING, supplying BOOKS of REFERENCE, taking the requisite LEVELS, and furnishing SECTIONS thereof, and ascertaining the LIMITS and BOUNDARY LINES of the LANDS within the jurisdiction of the COMMISSIONERS appointed, under an Act of the 9 & 10 VICTORIA, Session 1846, for IMPROVING the DRAINAGE of the VALLEYS RYE and DERWENT, in the North and East Ridings of the COUNTY of YORK.

"*Survey and Maps.*

"1st. That the surveyor contracting for the work shall connect the whole of the lands affected by this drainage by a system of base lines similar to those recommended by Captain Dawson, of the Tithe Commutation Office; and that he shall now survey in detail within the immediate vicinity (say, one field from the watercourse on each side) of the rivers Rye and Derwent, and other important watercourses, and wherever the valuers may point out to him as being advisable, and by plotting this survey of the main lines and detailed survey of the rivers and their vicinities, he will then form a framework by which he may fit the whole together. He shall not make use of any existing plans or documents for this part of the work, except a copy of the Ordnance survey, but use accurate existing commutation and other maps of that portion of the lands more remote from the chief watercourses, and by fitting them on to the above framework he will be able to judge of their accuracy. This original map must be at a scale of 4 chains to 1 inch, and drawn on the best drawing-paper, mounted on linen and bound. The base lines of the survey must be shown on this map in faint red lines, and numbered to correspond with the field-books, which, together with all the field-books of the parts newly surveyed, must be delivered up to the valuers at the same time as the maps, in the same manner as in the Tithe Commutation. The field-books must be perfectly plain and capable of being scrutinized by the valuers, or whom they may appoint. This map must represent the boundaries of all parishes and townships, and state the names of each; it must show the boundaries of each field or parcel of property, roads, watercourses, mills, mill-dams, shoals, buildings, cloughs, &c., with their

names; a number must be inserted in every field or parcel of property corresponding with that in the book of reference hereinafter mentioned, and each parish must be numbered separately—that is, he must begin with No. 1 in each parish. He must accurately ascertain and show on the maps the average flood-water line, and the lands liable to inundation must be distinguished by colour or otherwise. The exact course where levels are taken must be noted on the map in faint dotted red lines; and the situation of the stakes, bench marks, &c., and all descriptive particulars as to heights, sufficiently plain at once to enable the valuers to refer to them and the book which will contain a description of the levels hereinafter alluded to.

" *Reduced Map.*

" 2nd. That the surveyor shall furnish another map, at a scale of 12 chains to 1 inch, containing all the same particulars as the other, with the exception of the main lines of the survey, and shall be similarly drawn on the best drawing-paper, mounted on linen.

" *Tracings for Valuers.*

" 3rd. That the surveyor shall furnish three tracings, mounted on calico, of the map of 4 chains to 1 inch, to the valuers and umpire for their use.

" *Books of Reference.*

" 4th. That the surveyor shall make out a correct collected book of reference, taking each parish separately, and the name of the townships (if any) within the parishes must also be stated, setting forth the number of each field or parcel of property on the map, the names of owner and occupier, quantity in acres, roods, and perches, and state of cultivation, which shall also exhibit each person's total ownership or occupation in the whole work; and shall furnish one copy with each map, and one with each tracing, for the use of the valuers and umpire, making in all five copies.

" *Levels.*

" 5th. That the surveyor shall take a system of levels up the valleys of the Rye and Derwent, and across all lands liable to inundation or likely to be benefited by this drainage, having reference to one fixed datum point. He will advise with the valuers on the most proper mode of taking his levels; but most probably he will find it desirable to take lines of longitudinal levels (all connected of course) up the principal valleys, and at every 20 chains or so, and cross levels across the valleys at or about right angles to them. He must drive in stakes at every 10 chains distance on the lines of levels, which stakes must be of sound red pine, 2 feet 6 inches in length and $1\frac{1}{2}$ inch square, and must be driven 2 feet into the ground, thus leaving 6 inches out, which must be painted white, and the relative height of the ground at that point to the datum must be stated on the stake, either by being branded or painted in black figures; and a uniform cut must be made round the stake in the earth; all these stakes must be numbered consecutively, and the same number must appear on the plan section and book of reference to the levels. He must leave permanent bench marks on the coping of bridges or any other available fixed points at not more than 1 mile apart; all the bench marks must be marked alike, and cut into the stone, &c.

" *Section.*

" 6th. That the surveyor shall furnish sections of all his levels at a scale of 4 chains to 1 inch horizontal, and 20 feet to 1 inch vertical measure; the datum must be fully and particularly described; and the bottoms of all brooks or water-courses crossed by the lines of levels, heights of the points where pegs are driven in, permanent bench marks, crossing of roads, &c., must be noticed; and the vertical height in feet and inches from the datum line shall be written up to each of these points. The level line of average flood-water must also be shown.

" *Reference to Levels.*

" 7th. That the surveyor shall furnish a book of reference to the section, setting forth every particular and explanation requisite which shall refer to the stakes, bench marks, and other objects on the plan and section, and will also contain the surveyor's remarks on what he may consider to the point.

" *Time for Completion of the Work.*

" 8th. That a portion of the tracings of map and of the book of reference must be placed in the hands of the valuers on or before the 15th of May, 1847; and the

surveyor must continue to supply them with additional tracings and reference as they may require; and the whole of the tracings and books of reference must be in the valuers' hands by the end of June next ensuing; and the whole of the maps and books of reference hereinbefore mentioned shall be completed and delivered up to the Commissioners on or before the 31st of August, 1847.

"*Penalties for the Non-Completion of the Work by the Time specified.*

"9th. In default of the work not being completed by the times specified, the contractor to forfeit one hundred pounds, to be deducted from his bill, unless the valuers and umpire unanimously see cause to remit this penalty.

"*Should Maps be found inaccurate.*

"10th. The whole of the maps, sections, and books of reference to be done in a neat manner, and the field-books of the survey delivered up, and the whole work to be subject to the approval of the valuers and umpire, or whom they may appoint; and in the event of any portion being found inaccurate or insufficient, the valuers to appoint a fit and proper person to correct the same, and his charges to be paid out of the original contractor's bill.

"*The Contractor to have no Overcharge.*

"11th. The contractor must pay all his own expenses whatsoever, all stationery, labourers' wages, stakes, &c.; and have no further charge than those stated in his Tender.

"*Tender.*

"12th. The Tenders must distinctly state—

1stly. At how much per acre the party tendering will new survey the portions required to be so treated.

2ndly. At how much per acre he will compile and bring to the requisite scale accurate existing commutation and other maps.

3rdly. At how much per acre he will furnish all maps, tracings, and books of reference.

4thly. At how much per mile he will take the levels, and supply the section and books of reference thereto.

"13th. The contractor's bill to be scrutinized by the valuers and umpire, and passed as correct before he is paid; and after which scrutiny no other deduction can be made from his bill.

"14th. That a sum of money not exceeding one hundred pounds may be paid on account during the progress of the work, at such times and in such proportions as the valuers and umpire may direct.

"15th. That in case of one or more of the tracings or books of reference being dispensed with, the Tender to state how much per acre will be deducted from each."

No. 4.—Rye and Derwent Drainage Act.—A Summary of the Lands Surveyed, Excluded, and Chargeable.

Parishes.	Townships.	Total of Lands Surveyed, &c.			Lands Excluded.			Lands Charged.		
		A.	R.	P.	A.	R.	P.	A.	R.	P.
Thornton . .	Thornton	1324	3	27	321	2	31	1003	0	36
Ellerburn and Thornton . .	Ellerburn and Thornton	826	0	1	265	1	37	560	2	4
	Wilton	851	2	7	330	2	4	521	0	3
Pickering . .	Pickering . . .	3406	0	4	521	3	10	2884	0	34
	Pickering Marishes.	2638	1	24	183	1	6	2455	0	18
Old Malton . .	Old Malton . . .	1218	1	9	423	3	34	794	1	5
Allerston . .	Allerston . . .	1510	3	15	540	3	19	969	3	36
Kirby Misperton	Kirby Misperton .	1227	1	9	293	2	4	933	3	5
	Ryton	2270	3	1	453	1	17	1817	1	24

A Summary of the Lands Surveyed, Excluded, and Chargeable—*continued.*

Parishes.	Townships.	Total of Lands Surveyed, &c.			Lands Excluded.			Lands Charged.		
		A.	R.	P.	A.	R.	P.	A.	R.	P.
Kirby Misperton	Great and Little Barugh . . .	1257	1	9	144	1	33	1112	3	16
	Great Habton . .	860	0	13	184	1	27	675	2	26
	Little Habton . .	305	1	26	56	2	21	248	3	5
Normanby . .	Normanby and Rook Barugh . . .	1489	3	14	440	3	1	1049	0	13
	Thornton Riseborough	323	1	14	97	3	12	225	2	2
Barton-le-Street .	Barton-le-Street . .	880	1	0	723	0	10	157	0	30
	Butterwick . . .	615	0	33	212	1	33	402	3	0
Appleton-le-Street	Appleton-le-Street .	397	1	38	94	3	30	302	2	8
	Broughton . . .	332	1	33	54	0	20	278	1	13
	Swinton	516	3	30	96	1	8	420	2	22
	Amotheoby and Newsham . . .	1027	3	37	153	2	25	874	1	12
Slingsby . . .	Slingsby	1112	2	36	503	2	6	609	0	30
Hovingham . .	Hovingham . . .	296	0	5	123	1	16	172	2	29
	South Holme . .	557	3	29	118	2	39	439	0	30
	East Ness . . .	377	3	21	13	3	1	364	0	20
	Water Holmes . .	324	2	29		..		324	2	29
	Wath	17	0	21	17	0	21		..	
	Fryton	144	1	7	124	3	36	19	1	11
Stonegrave . .	West Ness . . .	176	3	26	3	3	8	173	0	18
Great Edston .	Great Edston . .	481	2	23	164	3	6	316	3	17
	North Holme . .	541	0	25	241	2	28	299	1	37
Salton . . .	Salton	1513	2	22	156	3	17	1356	3	5
	Brawby	1026	0	19	150	3	18	875	1	1
Kirkdale . . .	Welburn . . .	251	3	38	69	3	18	182	0	20
	Muscoates . . .	730	0	13	278	1	38	451	2	15
Nunnington . .	Nunnington . . .	441	1	28		..		441	1	28
Kirby Moorside .	Kirby Moorside and Bowferth . . .	594	2	4	297	2	27	296	3	17
	Keldholme . . .	98	3	8	5	2	13	93	0	35
Sinnington . .	Sinnington . . .	189	2	26	10	2	30	178	3	36
	Marton	412	3	16	33	0	27	379	2	29
	Little Edston . .	112	2	24	6	1	36	106	0	28
Middleton . .	Middleton and Keld-head	617	1	7	118	2	33	498	2	14
	Wrelton	14	0	19	14	0	19		..	
	Aislaby	200	1	8	151	2	30	48	2	18
	Cropton	83	0	24	28	3	33	54	0	31
Yeddingham. .	Yeddingham . .	603	3	16	98	3	11	505	0	5
Wintringham .	Wintringham . .	584	2	38	285	3	7	298	3	31
	Knapton	1208	0	27	527	2	28	680	1	39
Rillington . .	Rillington . . .	1049	0	0	726	0	16	322	3	24
	Scampston . . .	1003	1	2	685	3	18	317	1	24
Settrington . .	Settrington and Scag-glethorp . . .	1160	0	21	944	2	4	215	2	17
Norton . . .	Norton	330	0	32	223	1	23	106	3	9
		39,536	2	38	11,720	0	29	27,816	2	9

No. 5.—FORM of the CLASSIFICATION of LANDS, and RELATIVE AMOUNT of RATES, exhibited by PART of the TOWNSHIP of SLINGSBY as under.

Land Owners.	Occupiers.	No. on Plan.	Cultivation.	Quantities.	Lands Excused.	Lands Charged.	1st Class, 10s. per Acre.	2nd Class, 8s. per Acre.	3rd Class, 6s. per Acre.	4th Class, 4s. per Acre.	5th Class, 2s. per Acre.
				A. R. P.	A. R. P.	A. R. P.					
Earl Carlisle	W. Brigham	1	Arable . .	12 0 17	..	12 0 17	..	6 0 17	..	..	6 0 0
,,	,,	2	Bank Pasture	1 1 8	..	1 1 8	..	1 1 8			
,,	,,	3	Arable. .	7 3 15	..	7 3 15	..	3 3 15	..	..	4 0 0
,,	,,	4	,,	7 1 20	..	7 1 20	..	3 1 20	..	..	4 0 0
,,	,,	5	,,	7 3 5	..	7 3 5	..	7 3 5			
,,	,,	6	Pasture .	16 1 38	..	16 1 38	..	16 1 38			
,,	,,	7	,,	14 1 34	..	14 1 34	..	14 1 34			
,,	,,	8	Arable. .	10 1 8	..	10 1 8	..	10 1 8			
,,	,,	9	Bank Pasture	0 3 36	..	0 3 36	..	0 3 36			
,,	,,	10	,,	1 2 32	..	1 2 32	..	1 2 32			
,,	,,	11	,,	10 2 0	..	10 2 0	..	10 2 0			
,,	,,	12	,,	18 0 22	..	18 0 22	..	18 0 22			
,,	,,	13	,,	1 2 32	..	1 2 32	..	1 2 32			
,,	,,	16	,,	10 3 16	..	10 3 16	..	10 3 16			
,,	,,	17	,,	4 3 22	..	4 3 22	..	4 3 22			
,,	,,	18	,,	5 0 33	..	5 0 33	..	5 0 33			
,,	,,	28	,,	3 2 6	..	3 2 6	..	3 2 6			
,,	,,	29	,,	4 1 37	4 1 37						
,,	,,	30	,,	4 2 24	4 2 24						
,,	,,	32	,,	8 0 16	8 0 16						
,,	,,	33	,,	4 3 14	4 3 14						
,,	,,	34	,,	2 3 18	2 3 18						
,,	,,	35	,,	0 1 13	0 1 13						
,,	,,	36	,,	1 0 24	0 3 4	0 1 20	..	0 1 20			
,,	,,	37	,,	1 1 18	0 2 28	0 2 30	..	0 2 30			
,,	,,	115	Arable . .	3 3 38	..	3 3 38	..	..	3 3 38		
,,	,,	116	,,	5 1 16	..	5 1 16	..	..	5 1 16		
,,	,,	117	,,	6 1 37	..	6 1 37	..	..	6 1 37		

,,	,,	118	,,	3 0 11	. .	3 0 11	. .	. .	3 0 11		
,,	,,	119	,,	3 3 16	. .	3 3 16	. .	. .	3 3 16		
,,	,,	120	,,	6 1 34	. .	6 1 34	. .	. .	6 1 34		
,,	,,	121	,,	4 0 0	. .	4 0 0	. .	. .	4 0 0		
,,	,,	122	,,	3 0 38	. .	3 0 38	. .	3 0 38			
,,	,,	159	,,	7 0 22	7 0 22						
,,	,,	160	,,	4 3 32	4 3 32						
,,	,,	173	,,	6 0 10	6 0 10						
,,	,,	174	,,	2 3 33	2 3 33						
,,	,,	175	,,	4 3 36	4 3 36						
,,	,,	176	,,	8 1 3	8 1 3						
				233 2 34	61 0 10	172 2 24	. .	125 1 32	33 0 32	. .	14 0 0
,,	John Flower	14	Bank Pasture	1 2 20	. .	1 2 20	. .	1 2 20			
,,	,,	15	,,	5 1 20	. .	5 1 20	. .	5 1 20			
,,	,,	38	,,	10 0 6	6 2 6	3 2 0	. .	3 2 0			
,,	,,	39	Bank . .	0 1 20	. .	0 1 20	. .	0 1 20			
				17 1 26	6 2 6	10 3 20	. .	10 3 20			
,,	John Hicks	19	,,	5 3 9	. .	5 3 9	. .	5 3 9			
,,	,,	20	,,	7 1 0	. .	7 1 0	. .	7 1 0			
,,	,,	21	,,	10 3 7	. .	10 3 7	. .	10 3 7			
,,	,,	22	,,	8 3 15	. .	8 3 15	. .	8 3 15			
,,	,,	23	,,	11 0 7	. .	11 0 7	. .	11 0 7			
,,	,,	24	,,	6 2 12	. .	6 2 12	. .	6 2 12			
,,	,,	25	,,	6 0 32	6 0 32						
,,	,,	26	,,	6 1 30	6 1 30						
,,	,,	27	,,	16 1 15	4 0 15	12 1 0	. .	12 1 0			
,,	,,	31	,,	3 2 29	3 2 29						
,,	,,	210	,,	1 3 1	1 3 1						
				84 2 37	22 0 27	62 2 10	. .	62 2 10			

Township of Slingsby.

Summary.—Classification of Lands, and Relative Amount of Rates.

Landowners.	Occupiers.	Quantities.	Lands Excused.	Lands Charged.	1st Class, 10*s.* per Acre.	2nd Class, 8*s.* per Acre.	3rd Class, 6*s.* per Acre.	4th Class, 4*s.* per Acre.	5th Class, 2*s.* per Acre.
		A. R. P.	A. R. P.	A. R. P.					
Earl Carlisle .	William Brigham	233 2 34	61 0 10	172 2 24	..	125 1 32	33 0 32	..	14 0 0
,,	John Flower .	17 1 28	6 2 6	10 3 20	..	10 3 20			
,,	John Hicks . .	84 2 37	22 0 27	62 2 10	..	62 2 10			
,,	George Hill .	53 2 28	8 2 27	45 0 1	10 3 30	..	27 0 25	..	6 3 26
,,	Thomas Magson	43 2 20	7 3 9	35 3 11	..	..	34 2 23	1 0 28	
,,	Isaac Elliott .	17 0 39	..	17 0 39	..	..	17 0 39		
,,	Robert Kneeshaw	73 1 8	28 3 12	44 1 36	9 0 16	..	14 3 10	9 2 30	10 3 20
,,	Robert Hood .	32 1 37	16 0 39	16 0 38	6 1 29	..	8 1 9	..	1 2 0
,,	George Johnson	42 2 34	19 0 0	23 2 34	..	..	23 2 34		
,,	Jon. Coulson .	50 1 15	6 3 24	43 1 31	..	5 3 17	3 0 0	20 3 32	13 2 22
,,	William Boyes .	111 2 36	92 3 4	18 3 32	..	10 2 0	..	8 1 32	
,,	James Kneeshaw	48 1 36	43 1 36	5 0 0	..	..	..	5 0 0	
,,	J. Thornton .	4 2 2	..	4 2 2	..	..	4 2 2		
,,	John Smith. .	4 3 27	..	4 3 27	..	..	4 3 27		
,,	George Boyes .	21 3 26	13 1 23	8 2 3	..	..	8 2 3		
,,	John Hesp . .	5 3 24	3 2 8	2 1 16	..	..	2 1 16		
,,	Thomas Chapman	4 1 27	4 1 27						

,,	Thomas Harrison	3	2	0	3	2	0																		
,,	Thomas Pearson	1	1	22	1	1	22																		
,,	Elizabeth Granger	4	1	33	4	1	33																		
,,	George Wildon	1	2	38	1	2	38																		
,,	Hannah Hudson	4	1	3	4	1	3																		
,,	William Harrison	1	3	36	1	3	36																		
L. R. W. Ward	,,	86	0	20	45	0	26	40	3	34	10	2	8		..		26	3	26		..		3	2	0
The Poor of Slingsby.	,,	7	3	0	2	3	20	4	3	20		..			..		1	1	20	3	2	0			
,,	Robert Kneeshaw	18	0	34	2	0	34	16	0	0	6	2	0		..		7	0	0		..		2	2	0
,,	John Hesp . .	3	0	36		..		3	0	36		..			..		3	0	36						
Matt. Lawson	Himself . .	23	3	18	20	2	18	3	1	0		..			..			..			..		3	1	0
Thomas Bell	,,	8	1	16	5	3	16	2	2	0		..			..			..		2	2	0			
John Harper.	,,	49	3	28	27	3	12	22	0	16		..			..			..		22	0	16			
Wm. Brigham	,,	7	0	2	7	0	2																		
R. Thompson	,,	5	3	4	5	3	4																		
Rev. W. Walker	,,	2	0	0	2	0	0																		
Thos. Ireland	,,	32	0	10	32	0	10																		
		1112	2	36	503	2	6	609	0	30	43	2	3	215	0	39	220	3	22	73	1	18	56	0	28

21*st September*, 1849.

(Signed) DANIEL SEATON.
SAMUEL VESSEY.


PARISH
OF
SLINGSBY.
TOWNSHIP OF SOUTH HOLME.
BUTTERWICK.
BARTON.
TOWNSHIP OF FRYTON.
TO
SLINGSBY.
Slingsby Beck.
Drain.
Drain.
Drain.
Foot Path
Sewer.
To Nes.
To Newsham &c.
Grey Barn.
SCALE OF CHAINS.
0 3 6 9 12 24 36 48 60

X.—*On Mr. Bickford's Method of Irrigation.* From Mr. Archer.

To Mr. Pusey.

Sir,—I have just seen Mr. Bickford, who tells me that he has recently returned from Pusey, where he has been employed by you to introduce his new system of irrigation, and that you are desirous of receiving the opinion of its success from any who have put the system in practice.

I should premise that, having a good deal of water meadow, or land capable of being watered, the water also being of excellent quality, issuing from the trap rock, I had previously turned a good deal of attention to the subject of irrigation; and some years ago laid out at some expense about 20 acres of my lawn on the "drop system," then supposed to be the most approved method. With this, however, after one winter's experience, I was thoroughly dissatisfied. It did not allow for heavy gushes of water from rain, &c., and was a cumbersome business, requiring an attendant constantly on the spot to regulate it.

I then partially obviated the "gushing" evil, by cutting, as in Mr. Bickford's system—"watering" gutters, taken out of and parallel to the "carrying" gutters; but the slovenliness arising from the want of the *even distribution* of water as effected by his system, and the consequent requisite "looking after" the man in charge of the water meadows, proved such a constant source of discomfort and annoyance, that I had nearly determined in the present winter not to incur even the expense of cleaning up my gutters, when I read Mr. Bickford's article.

On carefully perusing this, I was satisfied he had furnished to the Journal a very valuable article, and accordingly I went to Crediton to see Mr. Bickford, and visit in his company some of the meadows laid out on his system, the result of which was so conclusive to my mind, that I engaged him to come to me in November last, and experiment upon a small 2-acre meadow contiguous to my farmyard, reserved for weakly lambs in the spring, but which had never been irrigated, through fear of the lambs tumbling into the large gutters used under the old system.

Half a wet winter's afternoon sufficed to cut the gutters with the plough used by him after being dialled out; and the water being laid on, distributed itself beautifully and evenly over the surface. It was interesting to watch the *horizontal gutters* gradually filling and discharging themselves, while at the same time a slight "weep" would be just perceptible in the *vertical* gutters, insen-

sibly enlarging itself into a little stream, which, falling into the horizontal gutter next below, again filled that, and so on, until the whole slope was under water. The result has been surprising, converting a somewhat dry hungry meadow into a little oasis.

It being obvious that a system so simply and entirely *practical*, which commanded success on a small scale, must answer equally to any extent, I proceeded to apply it to about twenty acres more, the result of which was equally happy; and, from the approbation the system has elicited from the many practical farmers who have come to witness the operation, I have no doubt of its becoming generally in use in this neighbourhood in another winter. Indeed, Mr. Bickford has been since employed on a contiguous estate (that of Mr. Rodd, of Trebartha Hall), so satisfied was the bailiff of that gentleman—an intelligent though somewhat prejudiced agriculturist—of the superiority of the system.

Its merits may be briefly stated to be—an even distribution of the water, realising the long-desired acme of perfection in watering, viz., that you should be able to walk over the land without wetting your feet. It applies equally to a large or small stream, because, by removing the stops in the upright gutters, you can water (acting upon Mr. Bickford's advice, always to water in *vertical* and never in *lateral* sections) to the extreme or any part desired of such section. It can be effected at about half the expense of the old system; and last, not least—an especial recommendation to tenant farmers—requires but little superintendence.

I should remark that, though it would be highly desirable to secure Mr. Bickford's * services on first introducing his system into a new district, yet it is so simple, that any old "gutterer" would acquire the system sufficiently in a week to be able to carry it out well enough for all practical purposes. Certain ingenuity appears to be required, as well as practice, for cutting the vertical gutters, but a few failures (and the consequences of failures are so perceptible when the water is laid on, and so easily remedied by the readiness with which the sods, being cut with a die, and therefore fitting exactly, may be transferred from one gutter to another) will soon put a man of common intelligence in full possession of the system.

Mr. Bickford fully concurred with me in objecting to watering from the leading-in or carrying gutter, with a view to saving land by avoiding a second gutter. The latter should be always the

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* Mr. Bickford and Mr. Ellis have irrigated some meadows for me apparently with great success last winter, of which I hope to give some account in a succeeding Journal.—PH. PUSEY.

running way of the water, and, where the stream is small, I should recommend each watering gutter to be *just the length of each vertical section.* With old "gutterers" there is an adage, "The more gutters the more grass;" and I am confident you cannot properly irrigate without the second gutter.

On one point we are at issue: he prefers to irrigate with water fresh from the spring, whereas I greatly prefer a pond, conceiving that stagnation and exposure to sun and air has a tendency to soften and mellow the water, although it may be true that it is only the *surface* of the pond which is so exposed.

Finally, I would say that, although Mr. Bickford does not claim the merit either of the discovery of the system or the implements he uses (the A level will be found delineated at the end of vol. i. of British Husbandry, there denominated a "rafter level"), yet he is entitled to the credit of having, by adaptation and application of those implements, "*worked out*" a system of the most signal advantage, from its simplicity and efficacy, to every man who has a bit of water-meadow on his estate.

He has only further to consummate the benefit he has conferred on the irrigator, by teaching him how to consume the grass to the best advantage; and, on suggesting this to him, I was glad to find he was turning his attention to the subject. From November to March is a long time for the farmer to afford his land to remain unstocked with sheep; and, as our heaviest rains usually fall in the west of England from November to Christmas, this period is, of course, most favourable for the process of irrigation; in fact, in this district our grass grows *naturally* up to December, and often later. Farmers, therefore, generally make a practice of eating the "bite" thereby produced at once, which they say they may as well do as "allow the frost to eat it:" the consequence of which is, that, as the waters fail after Christmas, a second bite can hardly be got on for the time when it is most required, viz., in March, for the ewes and lambs.

I am, Sir, your obedient servant,

EDWARD ARCHER.

Trelaske, near Launceston,
12th March, 1853.

XI.—*A detailed Report of the Drainage by Steam-power of a Portion of Martin Mere, Lancashire.* By Henry White, Land Agent, &c., Warrington.

Introduction.—Martin Mere might with propriety be termed the *Great Fen of Lancashire.* It is situate about 17 or 18 miles north of Liverpool, within a mile or two of the well-known and much-frequented sea-bathing place of Southport, and is separated from the sea by a slight ridge of land, only varying from a quarter of a mile, or less, to a mile in width. The district of what is termed Martin Mere extends over several thousand acres, all much lower than the level of the sea at high-water, and belongs principally to Charles Scarisbrick, Esq., but large portions are also owned by Sir Thomas G. Hesketh, Lord Derby, and Mr. Legh Keck. The Mere comprises portions of the townships of North Meols, Scarisbrick, Burscough, Rufford, and Tarleton.

Up to the end of the seventeenth century this *Mere* was really what its name indicates—a large pool of water (in area 3632 acres); indeed, in winter it still has too much of this appearance, notwithstanding the efforts that have been made from time to time to lay it dry. In the year 1786, Mr. Eccleston, who then resided at Scarisbrick Hall, sent an account to the Society of Arts of what had been done by others and himself up to that date with the view of draining this extensive but shallow lake. A copy of this very interesting account is given in Dr. Aikin's 'Manchester,' a topographical work published in 1795.* From this report it appears that a Mr. Fleetwood, then resident at Bank Hall (now the seat of Mr. Legh Keck, and situate a short distance north of the Mere), gained the consent of the other proprietors to his obtaining an Act of Parliament for the drainage of the Mere; and shortly afterwards, having leased the land under the powers of the Act, he made a portion of the large open drain or canal well known at present as "the Sluice." He also put down flood-gates near its outlet. In consequence of the deposit of sand which took place up to the gates on the side next the sea, he determined, in 1714, upon raising the sill of the gates 20 inches. Notwithstanding these supposed improvements, it appears that at this period "the Mere lands for many years were only made use of as a poor, fenny, watery pasture for the cattle of the neighbourhood, and that for a part of the summer months only." In the year 1717 Mr. Fleetwood died.†

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* "A Description of the Country from thirty or forty miles round Manchester. The materials arranged and the work composed by J. Aikin, M.D., Stockdale, London. 1795.

† This Mr. Fleetwood was buried at the parish church of North Meols, which stands between one part of the Mere and the sea. The inscription, in Latin, on

Some time afterwards, Mr. Fleetwood's executors erected another pair of flood-gates, nearer the outfall, which proved beneficial. About the year 1750 Mr. Fleetwood's lease expired. In 1755 the flood-gates and walls were washed down by "a very uncommon high tide," but were rebuilt at the joint expense of the different proprietors, and were then made 14 feet wide. From this time the *Mere* remained in the hands of the proprietors, in a neglected state, until the year 1781, when Mr. Eccleston, according to his statement, obtained leases from all the proprietors (one only excepted), and immediately began the work of improvement. He erected three pairs of flood-gates, with paddles at the bottom of each for the purposes of flushing. These gates were 18 feet wide and 19½ high, and the sill was 5 feet lower than that of the gates first put down. In 1783 the sluice was extended further into the Mere, and the waters thereof, which were then very high, ran off in 5 days. The sluice was now nearly 5 miles in length. In 1784 Mr. Eccleston commenced ploughing a few acres of the land thus drained, and states that it "yielded a tolerable crop of spring corn; some yielded a very inferior kind of hay, and the rest was pastured." The following year he sowed 200 large acres* of corn: part of this was oats and part barley. The latter he sold at 11*l.* 17*s.* 6*d.* the large acre (the purchaser paying the expense of reaping, &c.), off land that before only let for 4*s.* per acre; and the oats he sold at 10*l.* 17*s.* 6*d.* per acre, off land which hitherto had produced nothing. Before the drainage, he says, "the best meadow-lands in the most favourable seasons did not let for more than 9*s.* per acre;" whilst afterwards he mowed some worth 3*l.*, and let off the grass of other land at 2*l.*, reserving the after-grass for his own cattle.

In 1789 Mr. Eccleston made a further report to the Society of Arts, informing them of the losses he had sustained by the failure of the banks of the river Douglas and of the Leeds and Liverpool canal, having caused an inundation of the Mere. After

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his monument in the church, and which has reference to his labours on the Mere, has been translated as follows:—

"Thomas Fleetwood, of Bank, Knight, descended from a Stafford family (and that one of the first), a truly noble, polished, and facetious man, and the delight of his circle. He wished his bones to be here laid, because he made into dry and firm land the great Martinensian Marsh, by the water having been conveyed through a fosse to the neighbouring sea,—a work which, as the ancients dared not to attempt, posterity will hardly credit. He likewise constructed, not far off, a handsome bridge over the estuary at no small cost, from a regard rather to the public good than to his own prospective advantage. These labours having been accomplished, he at length, alas! too soon, laid down and died, on the 22nd April, A.D. 1717, in the 56th year of his age."

* This, no doubt, refers to what is now more commonly termed "Cheshire measure," and which would be 423 statute acres. In Lancashire the use of customary measures still obtains: there are the *Cheshire* 64 square yards to the perch—the *Lancashire* 49 yards—the *West Derby* 42¼; besides the statute measure 30¼ yards.

this period he adopted the grazing system, and states that, "of all stock, *horses* have been found to answer best on the natural coarse grass and weeds, on the softest lands;" alluding, no doubt, to the softest portion of this Mere.

In the year 1809 Mr. Eccleston died, leaving the great work to be completed.

In 1813, it is reported, the sea-gates were again carried away. After this, it appears, four cast-iron pipes or cylinders—three of 3 feet diameter, and one of 3 feet 3 inches, with self-acting doors to each of their ends next the sea, were fixed alongside of each other at the entrance to the sluice and under the bridge near to Crossens. These cylinders remain to the present day, but are obviously insufficient to allow the speedy escape of the fresh waters, particularly during winter, and the consequence is, that that portion of the Mere which depends upon this "natural" drainage alone, is submerged for weeks together. When I last visited the spot on the 21st of February, 1852, after four or five days of fair weather, some hundreds, if not thousands, of acres were then flooded, and had been so for several weeks. I happened to be at the cylinders at the time of high-water ($\frac{1}{4}$ past 12), and the height of the tide on that day, as indicated by a Liverpool tide-table, was 16 feet 11 inches. The height above the bottom of the cylinders at the end next the sea, where the doors, which close with the tide, are fixed, was 8 feet 8 inches. The height of the water in the sluice at the other end of the cylinders was 4 feet 6 inches; so that, supposing the cylinders to be laid horizontal, and the datum, from which the figures are given on the face of the stone-work above them, to be the same, there was here a difference in the two levels of 4 feet 2 inches; consequently no water could drain off from the Mere until the tide had ebbed to at least 4 feet 2 inches below high-water. As the tides vary from between 10 and 11 to 22 feet in height, and are subject to further increase by westerly winds, there will be a certain length of time at *every tide* (excepting a few of the very *lowest*), *when drainage by these natural means is impossible.* This points to the necessity of having an increased number of cylinders or other outlets which will allow the *fresh waters to pass off rapidly during the period that the sea is below the level of the cylinders.* Some such plan is, I presume, contemplated by Mr. Scarisbrick, as three new sluices, quite parallel and close to each other, and of different widths, are now being made at some distance to the west of the former sluice, and which apparently are to empty themselves into the sea, about 100 or 150 yards from the present cylinders.

Plan of Operation.—I now come to the more immediate subject of this Report—*the drainage of* 1100 *acres of Sir Thomas Hesketh's portion of Martin Mere, by artificial means.* The whole of

this land is situate at the north-east end of the Mere, and drains into the sluice already referred to. Before proceeding with a detailed account of the work I will give a copy of a Report (as to this drainage) made by Robert Neilson, Esq., of Halewood, to the Inclosure Commissioners.

Mr. Neilson says,—

"In compliance with your instructions, I beg to submit the following official Report on the effect of the machinery erected by Sir Thomas George Hesketh, Bart., for the drainage of his portion of Martin Mere, in the townships of Rufford and Tarleton.

"The tract of land thus denominated, consists of about 5000 acres, which, for six months in the year, and occasionally for a longer period, has been hitherto entirely covered with water.

"The description of the soil is, for the most part, a peaty loam, chiefly consisting of alluvial deposit and decomposed vegetable matter, and resting on a substratum of sand, with some slight deposits of marl.

"In consequence of this periodical inundation, not only has the productive capability of the soil most materially deteriorated and its rental value diminished, from its incapability of being put into corn-cultivation, but the sanatory condition of the neighbourhood was unfavourably influenced by the exhalations which the subsidence of the stagnant waters—under the action of approaching summer—caused to pervade it. Of this tract of land there are four proprietors; 3000 acres being owned by Mr. Scarisbrick, 600 by the Earl of Derby, 400 by Mr. Keck, and 1200 by Sir Thomas Hesketh, the latter being separated from the former by a broad canal about four miles in length, to each of which, until very lately the above description equally applied.

"Impressed with an opinion of the real value of the land, of the complete practicability of such drainage, and the consequent pecuniary benefit to his employer, and the social benefit of the neighbourhood at large which such drainage would effect, Mr. Boosie, the present agent of Sir Thomas Hesketh, conceived the project of relieving that gentleman's property by means of a water-wheel driven by steam-power, which should discharge the water as fast as it accumulated.

"The project was one which involved a large and immediate outlay of capital for a hazardous and prospective benefit; but relying on the judgment and skill which his agent had already evinced on former occasions, Sir Thomas Hesketh did not hesitate, on the data and calculations submitted to his consideration by Mr. Boosie, to authorize him at once to proceed with the undertaking.

"The result proves that the confidence thus reposed has not been in the slightest degree misplaced.

"The best models in Cambridgeshire and Lincolnshire have been studied with care, and at a cost of upwards of 3000*l.*, including buildings and embankments; a steam-engine of 20-horse power, and a wheel of 30 feet diameter, have been erected, and which, for judgment in plan, skill and accuracy in the workmanship, and amount of operative efficiency, are not surpassed in England.

"Nor has there been less practical discernment in the planning of the leading watercourses; and the judicious arrangement, by which the operations of the wheel have been limited to that portion of land most in need of its assistance, while the waters of the higher levels have been conveyed away by a totally separate channel to the main canal. From every chance of inundation from this canal, Sir Thomas Hesketh's land is now protected by a dam 20 feet broad at the base, and from 3 to 4 feet above the level of highwater-mark. Into this

canal the whole of the water falling on the 1200 acres * is now lifted within a few hours of the heaviest rain, by the wheel to which I have alluded.

"I had an excellent opportunity of witnessing this, during my inspection of that portion of the property. The weather had been for some time wet, and heavy rain had fallen during the whole of the previous day; yet on my arrival soon after ten in the morning, I found that, though the wheel had ceased working at two o'clock, there was nearly 5 feet of difference between the surface of the water inside and outside the wheel.

"I may be permitted to express the extreme satisfaction I have experienced in the above survey: it is an unusual and gratifying incident to find the liberal and enlightened views of the proprietor so ably seconded by the skill and energy of the agent; nor is it less gratifying to know, that while the pecuniary resources of the one, and the official character of the other, will equally be benefited by the result, that benefit is shared also by all the inhabitants of the neighbourhood in the improved sanatory condition of the district thus drained.

"I feel it due to Sir Thomas Hesketh, exclusive of the pleasure it affords me, to make this ample report to the Commissioners, that they may be enabled, in the event of any further application on his behalf, to know the grounds on which I beg to recommend such applications to their most favourable consideration.

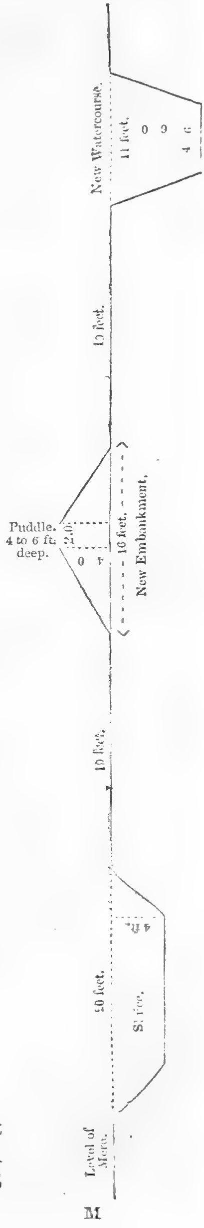
"*December* 11, 1850." (Signed) "ROBERT NEILSON.

To Mr. Boosie, of Rufford, near Ormskirk, who is thus so deservedly eulogised in Mr. Neilson's report, I am indebted for many of the facts, and for much of the information I have obtained with reference to this drainage. Mr. Boosie entered upon the agency at Rufford in January, 1847: in a short time afterwards he devised his plan of operation, and commenced with making his *catch-water drains*. The principal catch-water drain intercepts all the water flowing from the higher ground on the north side of the land drained (about 600 acres), and conveys it to the sluice: an embankment being required to pass it through the low ground as it approaches the outfall. The length of this catch-water drain is about 2¼ miles, and the fall about 7 feet. The object of these drains is obvious—the saving of the additional steam-power which would be required if the water from them was permitted to flow towards the engine. In July, 1849, Mr. Boosie visited the Pode-hole engines near Spalding, in Lincolnshire, for the purpose of getting information as to the working of those engines, also to assist him in determining the necessary power required for Sir Thomas's engine, and the best mode of constructing the water-wheel. Specifications for the engine and wheel were then prepared for him by a friend in Manchester,† and tenders were received from different parties for an engine of 20-horse power, and a wheel 30 feet in diameter. Messrs. Ben-

* Since the above was written, 100 acres, at a short distance to the south-east of the engine, which were on a sufficiently high level, have been drained into the sluice by a catch-water drain, thus relieving the engine, in some measure, of its work.—H. W.

† The gentleman here referred to is Mr. Robert Smith, Engineer, Old Trafford Hall, Manchester, who accompanied Mr. Boosie into Lincolnshire.

jamin Hick and Son, of Bolton, the celebrated engine-manufacturers, got the contract, and their work has given the greatest satisfaction.



In laying out the drainage works, Mr. Boosie availed himself of those very valuable plans now publishing by the Board of Ordnance, upon a scale of 6 inches to the mile, and which, when completed, will comprise the whole of the six northern counties of England. The levels taken were all checked by, and had reference to, the levels shown on these plans.

The embankments which had to be constructed were made with a slope of $1\frac{3}{4}$ to 1, and were puddled in the centre for 2 feet wide, and to a depth of 1 or 2 feet below the foundation. In the margin is a section of the embankment, sluice, &c., as they appear at a short distance to the west of the engine.

The new watercourse shown in the section is used for conveying the drainage water to the engine. The soil excavated from this was used in forming the embankment; and Mr. Boosie found that an excavation of 25 cubic feet was required to make good an embankment of 20.

From the preceding section it will be seen that the new watercourse was 19 feet from the foot of the embankment. Although so distant, yet, in forming the latter, it was necessary in one part of the work, where the foundation was a soft peat, to pile the ground for 30 yards in length, to prevent the weight of the embankment pressing *in* the side of the watercourse. In addition to this it was also thought desirable to divert a considerable length of the watercourse to a greater distance.

The mode adopted in piling is shown by the following sketch.

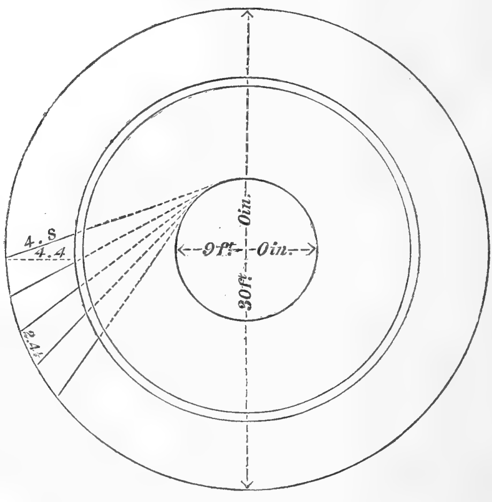
Side next Embankment.

The piles were young larch-trees, 18 to 20 feet long, and to them strong rails were transfixed and fastened by nails to a depth of from 2 to 3

feet below the surface. Faggots and brushwood were also used on the side next the embankment. The top of the whole of the piling was covered with clay.

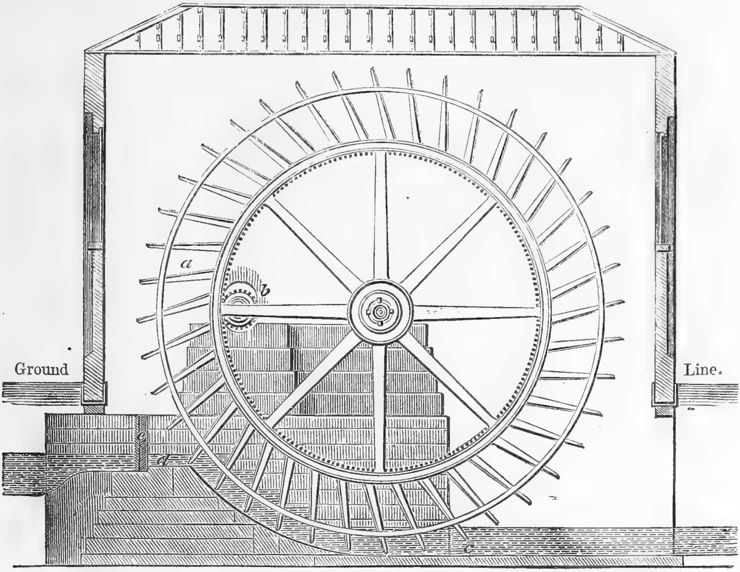
Description of the Engine and Water-wheel.—The engine is one of Messrs. Benjamin Hick and Son's independent frame engines, combining the high-pressure and condensing principle. The steam is admitted at the commencement of the stroke at about 30 lbs. on the square inch, and afterwards reduced to such a pressure before the termination of the stroke as to be easily condensed. This is effected by a peculiar arrangement of the steam-valves, by which the steam is cut off at different portions of the stroke according to the amount of work to be done: great saving is effected by this arrangement. This engine is nominally of 20-horse power, but can be worked up to considerably more, though it is not more than half loaded by its present ordinary work. The cylinder is 23 inches diameter, with a 3 feet stroke.

The scoop-wheel is 30 feet in diameter; the floats or pallets are 16 inches broad, working in a wheel-race of stone work $16\frac{1}{2}$ inches wide, and the extreme dip of the wheel is 4 feet 4 inches. The float-boards are 4 feet 8 inches long, and are set as tangents to a circle 9 feet diameter, as shown by the annexed drawing.



The speed at which the wheel is worked, and which is ascertained to be the best, is $4\frac{1}{4}$ revolutions per minute, or 400 feet at the periphery of the wheel. Subjoined is a section of the wheel and wheel-house.

Longitudinal Section of Scoop Wheel, &c.



a. The float-boards 4 ft. 8 in. long, 1 ft. 4 in. wide.
b. The pinion on the crank-shaft.
c. The wheel-race. Water shown 1 ft. 9 in. deep.
d. The breast to which the water is lifted.
e. Folding-doors, which are closed when the engine is not working, to prevent the water of the sluice flowing back into the wheel-race.

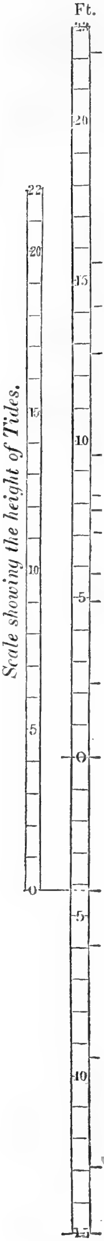
Scale 1–12th of an inch to a foot.

The *boiler* is one of 30-horse power. It is 26 feet long and 6 feet in diameter, with a flue through it of 2 feet 3 inches diameter, and 2 feet 8 inches in the fire-place. It is estimated that this boiler, with ordinary care, will last from fifteen to twenty years.

In answer to an inquiry which I made, from the manufacturers of the engine, they state there would be no objection whatever to making the wheel (and of course the wheel-race) 4 inches wider. Should this be done, I have no doubt the engine would be sufficient for the drainage of 1600 or 1800 acres.

For the information relative to the engine, &c., I am indebted to the makers, Messrs. Benjamin Hick and Son, of Bolton, who have also favoured me with the drawing of the wheel.

Comparative Levels.—The following scales exhibit the different levels of the district, with reference to the Ordnance datum, and to that from which the height of the tides are given :—



Ft.	in.	
22	2.	Bolt, or B. M. (Bench Mark) on the Parapet of the Bridge at Crossens.
15	7.	B. M. on Wigan's Lane Bridge, Rufford, near the Engine.
14	1.	Average of High Water, Spring Tides (18 ft. 3 in. above old Dock Sill).
12	8.	Top of Sir Thomas Hesketh's Banks (when put up).
9	6.	Level of Water in the Sluice and on Martin Mere.—Winter of 1848–9, and on 22nd February, 1852.
8	3.	*General Surface of Low Land on Martin Mere.*
7	9¼.	Breast of Stone-work, over which the wheel throws the Water.
7	1.	Average of High Water, Neap Tides (11 ft. 3 in. above old Dock Sill).
5	9.	Bottom of Sluice at Wigan's Lane Bridge—near the Engine.
4	10.	Bottom of Cylinders at Crossens (east end), being the outlet of Martin Mere water.
2	4½.	Bottom of the Arc of Scoop-wheel at the Engine.
0		*Mean Tide Level. Datum of Ordnance Survey.* 4 ft. 2 in. above old Dock Sill (or, according to some, 4 ft. 9 in.).
4	2.	Sill of old Dock Gates at Liverpool, from which the heights of the Tides are given.
5	11.	Average Low Water of Neap Tides (1 ft. 9 in. below Dock Sill).
9	5.	Mean Low Water, being the average of Spring and Neap Tides.
12	11.	Average Low Water of Spring Tides (8 ft. 9 in. below Dock Sill).

N.B.—The lowest tide in 1852 is 10 ft. 3 in 6th October.
The highest do. . . . 21 11 6th April.

Example.—A tide of 12 ft. 5 in. is level with the general surface of the low land on Martin Mere, which it will be seen is 8 ft. 3 in. above the mean tide level.

From the foregoing levels it will be seen that the ordinary "lift" of the water-wheel, when the water in the sluice is level with the breastwork of the wheel, is 5 ft. 4¾ in. (viz., 7 ft. 9¼ in. — 2 ft. 4½ in.); it happens, however, that frequently during winter the water in the sluice stands at 9 ft. 6 in., so that in fact the lift at this season may be averaged at 7 ft. 1½ in.

Reasons for fixing upon the present Site of the Engine.—1. The level of the ground at the engine and near it (referring to the Ordnance datum) is 12 to 13 feet, which is from 3 to 4 feet higher than most of the land along the line of sluice up to which it was desirable the engine should be placed. At this height, therefore, the work of erecting the buildings and the engineer's cottage could go on without fear of flood.

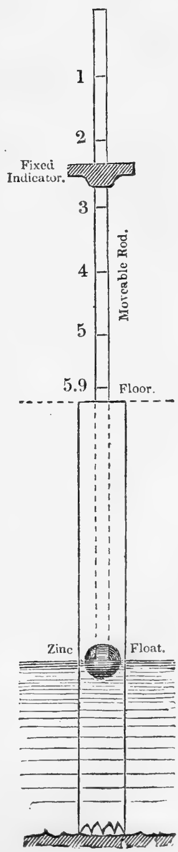
2. The foundation here was also good, being a bed of marl of several feet deep.

3. There is a good public road close to, by which the materials for building and the coal for the engine could be easily got to the spot.

4. The site is nearly equidistant from both extremities of the land requiring to be drained; so that the water reaches the engine in one half the time it otherwise would do if the engine were at the west end—that next the sea, and the most natural point of outfall.

Other reasons might be given in favour of the present site, but it is considered unnecessary to state them.

Statistics relating to the Drainage and Rainfall.—The engine commenced working for the first time on the 9th of April, 1850, but it was not until the 29th of March, 1851, that a regular account was kept, by which the *quantity of water lifted* could be calculated. The mode adopted for ascertaining this fact, is, I think, deserving of notice. The depth of the water in the wheel-race is ascertained by fixing in the wheel-house up to the wall near to where the water enters the building, a gauge or graduated rod, which is acted upon by a round zinc float, and indicates in feet and inches the exact depth of the water in the wheel-race. This will, perhaps, be better understood by reference to the drawing in the margin. The depth of water is noted by the engine-man soon after he commences working, and afterwards throughout the day, at intervals of generally two, but sometimes three hours.



These depths, and the times at which they were taken, are noted in a book kept in the following form:—

Date.		From February 4th to February 5th.								Working Hours.	Average Depth.	Remarks.
1852. Feb. 4 (Wedy.)	Times	h. m. 7 0	h. m. 10 0	h. m. 1 0	h. m. 4 0	h. m. 7 0	h. m. 10 0	h. m. 1 0	h. m. ..	18	..	Heavy rain for 7 hrs., and rain in the afternoon.
	Depths	ft. in. 3 0	ft. in. 2 10	ft. in. 2 11½	ft. in. 3 0	ft. in. 2 11½	ft. in. 2 11	ft. in. 2 10	ft. in. ..	..	ft. in. 2 11	
Feb. 5 (Thurs.)	Times	h. m. 1 0	h. m. 4 0	h. m. 7 0	h. m. 10 0	h. m. 1 0	h. m. 4 0	h. m. 7 0	h. m. 10 0	24	3 0¾	Heavy rain for 12 hrs.
	Depths	ft. in. 2 10	ft. in. 2 7½	ft. in. 2 7½	ft. in. 2 11	ft. in. 3 1	ft. in. 3 4	ft. in. 3 5½	ft. in. 3 4			
,,	Times	h. m. 1 0	..	..	..	..	..	..	..			
	Depths	ft. in. 3 4	..	..	..	..	..	..	..			

For the first ten days in February, of which the above two are a portion, the work required from the engine was greater than on any previous occasion.*

The engine worked during these ten days 194 hours. This included Sunday, a day on which the engine is seldom at work. On that day the average depth of water for eighteen hours was 3 feet 4 inches. The average depth for the ten days was about 2 feet 6 inches.

The following is an *abstract* from the engineer's book of the *work done by the engine* since the 29th of March, 1851, the time the registry was commenced, and to which I have annexed an account of the fall of rain at Rufford:—

	No. of Days the Engine worked.	No. of Hours the Engine Worked.	Weight of Water lifted in Tons.	Fall of Rain at Rufford in Inches.
1851.				
March	2	32	38,100	
April	17	95	107,910	0·98
May	17	108	88,302	1·70
June	20	140	166,530	4·10
July	8	30	31,740	2·76
August	9	38	43,560	3·72
September	9	42	50,610	2·25
October	28	236	328,370	5·28
November	25	206	282,690	2·02
December	18	102	132,480	0·80
1852.				
January	30	347	493,850	5·76
February (to the 19th inclusive)	19	298	475,140	3·58
	202	1674	2,239,282	32·95
Subsequent fall in February and March.	21	110	138,920	0·30
	223	1784	2,378,202	33·25†

* It will be remembered by many that the 5th February was the eventful day on which occurred the bursting of the reservoir at Holmfirth, the consequence of which was so calamitous.

† The gauge by which this was ascertained is fixed level with the ground in

By the above statement a comparison may be instituted between the amount of evaporation and absorption in *summer* and *winter.*

I have not thought it necessary to give the average depth of water in the wheel-race each month; but the average up to the 19th of February, 1852, was about 1 foot 10½ inches, and the average for the year would be nearly 2 feet.

As the engine drains 1100 acres, and the amount of rain-fall is 35½ inches, the total weight of rain for the year on that area would be 3,937,541 tons. From these results it would appear that 66 per cent. of the rain-water was collected by the drains and lifted by the engine, and 34 per cent. was evaporated and absorbed. The average annual evaporation of England for six years ending 1843 has been stated at 57·4.

Mode adopted in calculating the Quantity of Water lifted.—Presuming it may be useful to those who are seeking for information on the subject, the principle adopted in calculating the effective power of the wheel is here given.

The following are the data:—the speed of the wheel, its width, and the "dip" or depth of the water through which it passes. To show the application of these, let us assume the depth of water to be 2 feet. As the diameter of the wheel is 30 feet, the diameter of a circle, the arc of which passes through the centre of the water, will be 28 feet. Then the diameter being 28, the circumference will be $(28 \times 3{\cdot}146) = 87{\cdot}9648$ feet; from this deduct 10 feet for the space occupied by the 40 float boards and framing (being 3 inches for each), which will leave in round numbers 78 feet. Next multiply this 78 by the number of revolutions per minute (in this instance 4¼), and we get 331½; which again multiplied by the width of the float boards or scoops—1¼ feet (the exact width is 16 inches, but ½ an inch on each side up to the walls is considered unavailable), makes 414¼; this, multiplied by the depth—2 feet, is 828¾ nearly—say 829, the number of cubic feet discharged per minute. Then 829 divided by 36 *, gives 23 tons.

The following table shows the quantity of water discharged by this engine, at different *dips*:—

Mr. Boosie's garden at Rufford, which is about 31 feet above the sea.—By the same gauge it was ascertained that the fall of rain for the year 1847 was 38·54 inches; 1848, 45·11; 1849, 35·41; 1850, 35·35; and 1851, 33·49; making an average for the 5 years of 37·54 inches.—The average fall of rain in Deeping Fen, Lincolnshire, for the 6 years ending 1843, was only about 27 inches, which was the average of England for the same period.

* This may be taken as the number of cubic feet of water in a ton. A cubic foot of water (1728 inches) weighs 62½ lbs.; the *exact* weight of 36 feet, therefore, would be 1 ton 10 lbs.; a gallon of water (277¼ inches) weighs 10 lbs., and there are 224 gallons in a ton.

Dip.		Water Discharged per Minute.	
ft.	in.	Cubic feet.	tons.
1	0	432	12
1	6	645	18
2	0	829	23
2	6	1015	28
3	0	1194	33
3	6	1355	37⅔
4	0	1530	42

Capital expended in the Work.

	£.	s.	d.
Cutting catchwater drains to convey water from the higher lands to the sluice, and building culverts and bridges in connexion with the same	356	0	9
Cutting new watercourses to convey the drainage-water to the engine, deepening old watercourses, forming embankments, &c. &c.; the expense of the iron pipes at Sandyway included . .	1263	18	9
Engine-house and chimney (most of the materials—consisting of stone for the foundations of walls, chimney, engine and wheel, and bricks above, with slates for the roof—had to be carted 6 miles). The building is about 12 yards by 11; the chimney 6 feet 7 in. square at the base, and 20 yards high	735	13	8
Engine, boiler and wheel (as per contract)	1025	0	0
Extras.—Apparatus for disengaging scoop-wheel	9	10	0
Water-cistern over boiler-house, used for refilling the boiler	35	5	8
	£3425	8	10

The above items include the cost of a provision made in the machinery for working a saw mill, when the engine is not employed in driving the wheel, but this is not made available at present.

Now, that *fall* has been obtained, a further outlay has been called for in the under-drainage of portions of the land. This has been effected with pipe tiles, put in from 3 to 4½ feet deep, and about 12 yards apart. The soil is, in some places, of a loose sandy kind, and in others peaty. Not unfrequently sand and peat are found together, and by deep ploughing or digging are judiciously intermixed. The subsoil consists of peat, sand, and in some places marl. Considerable quantities of the latter have been thrown out of some of the main watercourses leading to the engine, and is now being applied to the peaty and sandy land with great advantage. Another improvement has been effected, in eradicating old fences and filling up useless ditches, and in planting new white thorn hedges. The cost of draining and of these improvements has been estimated at 1000*l.*

A further outlay was required at the *Mere House Farm*, in the erection of farm-buildings, a thrashing machine, and the repair of occupation roads. *This* has also been estimated at 1000*l.* About thirty or forty years ago there was a good pile of farm-buildings at this farm, but in consequence of the lost condition of the land, induced by want of drainage, the farm became deserted,

and the present Sir Thomas Hesketh's grandfather, considering the farm-buildings useless, removed them, but allowed the house to remain. Since that period the land has been in the occupation of the owner, and has hitherto afforded but a poor and scanty herbage to a few agisted cattle.

Annual Expenditure in maintaining the Engine and Works, and Interest of Capital invested.

							Cost per Acre for 1100 Acres.	
	£.	s.	d.	£.	s.	d.	s.	d.
Coal, viz. 200 tons of slack, including carting 3 miles and boating 9 miles. Cost at the canal, near the coal-pits, 1*s.* 6*d.* to 2*s.* per ton, according to quality. Cost when delivered, about 5*s.* 1½*d.*	51	9	8					
Deduct coal used by engine-man at his cottage, say	1	9	8					
				50	0	0	0	11
Wages of engine-man (including rent of cottage, 2 acres of land, and coal) . . .	39	0	0					
Occasional assistant	2	10	0					
				41	10	0	0	9
Oil, tallow candles, &c. &c.	. .			15	13	0	0	3½
Keeping embankments, watercourses, &c., in order, say	. .			15	0	0	0	3½
				122	3	0	2	3
Interest on capital expended in drains, embankments, engine, &c., 3425*l.* 8*s.* 10*d.*, at 7 per cent., repairs included * . . .	. .			239	15	7	4	4¼
Interest on capital expended in tile-drains, &c., 1000*l.* at 5 per cent.	. .			50	0	0	0	11
Interest on capital expended in farm-buildings, &c., 1000*l.*, at 4 per cent.	. .			40	0	0	0	8¾
			£	451	18	7	8	3

Estimated Value of the Land before and after Drainage.

	Quantity, Statute Measure.			Annual Value.					
				Before Drainage.			After Drainage.		
	A.	R.	P.	£.	s.	d.	£.	s.	d.
Land south of Sluice, and between Wigan's Lane and Sandyway . .	67	2	32	30	0	0	121	0	0
Land east of Sandyway, and between the Sluice and Mere Lane . . .	116	0	8	64	0	0	259	0	0
Mere House Farm, all west of Wigan's Lane (the *improved* value is in part accounted for by the newly erected farm-buildings)	230	0	0	70	0	0	350	0	0
Remainder of land	386	1	0	365	0	0	548	0	0
	800	0	0	529	0	0	1278	0	0

* The makers of the engine inform me that 12½ per cent. would be a fair allow-

In addition to this there are 300 acres, which are also drained by the engine, but which being on more elevated ground are taken as being of much the same value now as before.

The above estimates of the annual value of the land are founded on the past and present rental, with the exception of the Mere House Farm, and the woods and some other lands near "Mere Sands Wood," which are at present in hand.

Having myself, a few years ago, valued a considerable quantity of land very near to this, and similarly circumstanced as to drainage, at 10*s.* per acre, it will not be supposed that the above 800 acres are undervalued at 13*s.* As to the present value of the farm in hand, which is now estimated to be worth 350*l.*, or 30*s.* 6*d.* per acre, I may state that the tithe rent-charge is very low, that the rates are moderate, and that the crops in 1851 have been estimated as follows:—

Swedish turnips, 22 tons 1 cwt. per Stat. acre.
Common turnips, 25 ,, 19 ,, ,,
Oats, about 40 bushels (of 45 lbs.) per Stat. acre.
Barley ,, 47 ,, (of 60 lbs.) ,,
Wheat ,, 32 ,, (of 60 lbs.) ,,

		£.	s.	d.
Taking, then, the present annnal value of 800 acres to be		1278	0	0
And deducting the previous value	£ 529			
And the annual expense of the drainage works and interest of capital	452			
		981	0	0
There remains a net annual profit, exclusive of interest, of		£297	0	0

Concluding Remarks.—Independently of the pecuniary advantage derived from works of this nature, which, in this instance, considering the small extent of land drained, is very considerable, it will, I think, be admitted, that there are benefits of a social and sanatory kind, which claim our highest estimation. I cannot myself contemplate the improvement which has been here effected without feelings of the greatest satisfaction. The poorer classes have here had productive labour provided for them, where, before, labour was comparatively fruitless. Land which was swampy, sterile, and unfit for human habitation, is now dry, productive, and healthy. Works of this kind are not frequently undertaken; when they are, and successfully carried out, I think we confer a public good in making known the means by which such

ance upon the machinery for interest, depreciation, and repairs; but in the allowance of 7 per cent. I have included buildings and other works less liable to depreciation from wear and tear.

works have been effected. The example here furnished by Sir Thomas Hesketh might judiciously be followed by many, with advantage to themselves and to the community.

I cannot conclude this report without acknowledging the valuable assistance which has been freely afforded me by the late Mr. Boosie and Mr. Porter, his assistant, and for which I have much pleasure in now tendering my thanks.

February 28, 1852.

XII.—*On the relative Nutritive and Fattening Properties of different Natural and Artificial Grasses.* By J. Thomas Way, Consulting Chemist to the Royal Agricultural Society of England.

It is very generally known to those who have interested themselves in the history and progress of agriculture in this country, that at an early period of the present century the Duke of Bedford, impressed with the importance of ascertaining, so far as possible, the relative productiveness of different kinds of grasses, and also their relative nutritive value for the feeding of animals, set on foot a series of experiments at Woburn to determine these points. To Mr. George Sinclair the conduct of this investigation was deputed; and to this day Mr. Sinclair's excellent work, embodying the results that were obtained, remains the text-book on the grasses.

Mr. Sinclair's method of procedure was simple enough. He had two questions to determine: the first of these being the relative productiveness of different grasses, or, in other words, what quantity of each might be grown on a given area of soils of different qualities and capabilities. To determine this point, Mr. Sinclair had recourse to the obvious method of growing the different grasses in plots of a definite size, and carefully weighing the produce of each.

The second question—that of the nutritive quality of the grasses so grown—required for its solution an expenditure of greater skill; and Sir Humphry Davy was asked to suggest the proper methods.

The plan adopted by Mr. Sinclair, at the suggestion of this illustrious chemist, was also very simple. A given weight of the grass, either in its natural state or after being dried, was submitted to the action of hot water till all the soluble parts were taken up. The liquid was then separated from the undissolved woody matter by filtration, and carefully evaporated to dryness.

The dry product thus obtained was taken as the measure of the nutritive matter of the specimen examined.

In this way the greater number of the true grasses and other plants found in or suitable to pastures was carefully examined, and the results were published, as before stated, in Mr. Sinclair's work. There can be no doubt that this method of finding the nutritive matter of the plants afforded data which could not fail to be of value to the intelligent agriculturist, and that it was the best which the state of science at that time could offer, or which, with a moderate outlay of labour, was possible, is sufficiently guaranteed by the name of the great chemist who suggested it.

But chemistry and physiology have made gigantic strides since that time. We have learnt to separate and identify the chemical principles of which plants are made up, and their composition and properties have been intimately studied. Physiology, on the other hand, has taught us to a considerable extent the part which these principles play in the nutrition of animals. It has shown us that from one is formed flesh, from another fat, whilst to others, again, is allotted the office of supporting respiration and producing animal heat. It is not meant that science was entirely at fault on these points at the period in question, but there can be no doubt that the greater part of our present knowledge of the subject is of a much later date.

It is, therefore, not to be wondered at, that, with increased knowledge of the offices or functions of vegetable principles in relation to animal life, we should feel the want of a more correct acquaintance with the distribution of those principles in different plants; and it has been long evident to all who have paid any attention to these subjects, that Mr. Sinclair's determinations of nutritive equivalents for different grasses, however valuable they were at the time when they were executed, are quite unsuitable to our present more advanced stage of knowledge. This is so obvious a fact, that it would be almost unnecessary to occupy the pages of the Journal and the time of the reader in discussing it, were it not that I may at the same time show more plainly the grounds upon which the examination which it is the object of this paper to describe has been based.

It may be shortly stated that modern chemistry has divided the principles of plants into two great classes—the one including all those vegetable principles which contain *nitrogen;* the other comprising those which are destitute of this element.

The nitrogenous principles are essentially alike in composition, but differ somewhat in properties; they are known as vegetable albumen, casein, legumen, &c.: the first of these is soluble in cold water, but coagulates, and becomes insoluble when the water is boiled; the two last are insoluble in water either hot or cold.

The class of non-nitrogenous principles, omitting those which possess no general importance to our present purpose, includes woody fibre, starch, gum, sugar, mucilage, pectic acid, &c., together with different oily or fatty matters. Many of these are soluble in water, as sugar, gum, &c., whilst woody fibre, pectic acid, and starch, are insoluble in cold, and the two former even in hot water.

It is now almost universally conceded that the nitrogenous principles in plants are assimilated, or adopted as it were by the animal economy with little alteration, being, by processes that are easily conceived, converted first into blood, and then into flesh and muscle, all of which they so closely resemble in composition and properties. Little is known as to the relative adaptation of these different substances for assimilation into the animal body—whether vegetable albumen or vegetable casein, for instance, is more susceptible of conversion into flesh; and for the present, at least, we must be content to regard them in a general way as equally valuable in this respect. But this much is known, that the presence of members of the nitrogenous class is essential to the composition of nutritive food, and that starch or sugar alone is quite unfitted to support, much less to increase, the animal frame. On the other hand, the class of non-nitrogenous substances is equally necessary for the support of respiration and animal heat, and the production of fat. But, whilst physiologists make no great distinction between the members of the flesh-forming class, they allot to one set of non-nitrogenous principles the office of supplying the elements of respiration, and to another that of producing fat. Much dispute has existed upon this point—some physiologists asserting that the sugar and even the starch of their food might serve to form fat in animals, whilst others have held the belief that the fat which was deposited in the body must have pre-existed as such in the food. The question seems, however, to have resolved itself into this—that starch, gum, sugar, and oily and fatty matters, may each and all contribute to the respiratory and heat-producing functions; whilst, in the formation of fat, the ready-formed fatty matters take precedence; and, in their absence, first sugar and then starch may be employed for that purpose.

From what has been now said, it will appear that the plan adopted by Mr. Sinclair for the determination of the nutritive properties of the grasses was defective in more ways than one. In the first place, it afforded no kind of information as to the relative quantity of flesh-forming, fattening, and heat-producing compounds existing in the plants; and, in the second, it did not even give a correct idea of the proportion of all these substances

taken collectively—since, with our present knowledge of the properties of the nitrogenous principles, we cannot doubt that treatment with hot water would fail to extract the most nutritive portions of the grass.

As a supplement to Mr. Sinclair's excellent work, and a subject not unworthy of considerable labour, it seemed desirable to examine some of these grasses anew, bringing to the inquiry the aid of more recent physiological principles and the methods of modern chemical research. I freely own, however, that it may be objected to the analyses which are now published, that they do not, any more than those of Mr. Sinclair, put us in possession of the *whole truth*—such is the case; but, upon consideration, it will be found that the most important points are elicited by them and that they furnish a better means of judging than before existed.

To have undertaken the proximate analysis of so large a series of specimens as the grasses present,—to have separately ascertained the quantity of each different nitrogenous and non-nitrogenous principle they contained, would have been, if not impossible (within any moderate space of time) at least useless, for, as we have seen, our other knowledge of the nutrition of animals is not sufficiently advanced to enable us to make use of such data. But, on the other hand, it was possible to direct our efforts to the acquisition of that class of facts which could immediately be made available in relation to existing physiological knowledge; and with that view I decided upon ascertaining, so far as might be, not the quantity of each vegetable principle present in the different grasses, but that of each *class* of such principles. The analyses that follow will be found to embrace the following particulars:—

1st. The proportion of *water* in each grass as taken from the field. The necessity for this determination is obvious.

2nd. The proportion of *albuminous or flesh-forming principles,* including, without distinction, all the nitrogenous principles.

3rd. The proportion of oily or fatty matters, which may be called *fat-producing principles.*

4th. The proportion of elements of respiration or *heat producing principles,* under which head are comprised starch, gum, sugar, pectic acid, &c., in fact all the non-nitrogenous principles with the exception of fatty matters and woody fibre.

5th. Woody fibre.

6th. Mineral matter or ash.

It will be observed that some of these particulars are rather of negative than of direct interest; water, for instance, in a plant

is of no value in feeding animals, but its proportion is a necessary element of our calculations, because, with the variations in quantity of moisture, will be corresponding variations, though in the opposite sense, of the real nutritive matter of the plant.

The woody fibre of plants is considered to have no value in a nutritive point of view, except that (which, by the way, is sufficiently important) of giving bulk to the food. Still its determination in this respect was necessary, and was indeed an indispensable step in the process of analysis. The same may be said with regard to the mineral matter or ash.

Under the foregoing heads we have acquired, it is hoped, a very important amount of information—such, too, that it can be immediately brought to bear upon the practical nutritive values of the different grasses.

It is necessary to say a few words in regard to the history of the specimens examined. The grasses were collected for me in the spring and summer of 1849, by Mr. Bravender of Cirencester, to whom my best thanks are due for the execution of so laborious a task. It may give an idea of the labour of such a collection to state that upwards of sixty or seventy specimens were obtained by Mr. Bravender, each individual plant composing the sample of 2 or 3 lbs. weight which was necessary for the purpose of analysis, being picked separately from the meadows in which they were growing. I have elsewhere, in giving the analyses of the ashes of the grasses, stated my reasons for preferring to take the plants from meadows in which they were growing naturally and healthily, rather than seeking to raise them in one soil and under one set of circumstances which could not be equally favourable to all. Time also was a consideration, and the adoption of the latter plan would have entailed considerable delay.* The grasses were collected, plant by plant, at the time of flowering (except where otherwise stated), and forwarded immediately in tin cases to London for examination.

I shall not trouble the practical agriculturist with a description of processes which would be tedious to him and of no practical advantage; but, for the information of those who may wish to know the methods of analysis pursued, I shall add them in an Appendix to this paper.

To economise space and afford facilities for comparison, the

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* The analyses were in great part completed and ready for publication in 1850, but from several causes their appearance in print was delayed—a circumstance which I by no means regret, as it has enabled me to increase the value and extent of the investigation very considerably.

analyses are collected in Tables. I shall divide them into two classes, which, for convenience sake, may be called the natural and artificial grasses, respectively.

The Tables I. and II. contain the botanical and common names of each grass, the nature of the soil, and the date of collection of the different specimens.

TABLE I.—NATURAL GRASSES.

Botanical Name.	Common Name.	Date of Collection, 1849.	Nature of Soil.
Anthoxanthum odoratum.	Sweet-scented vernal grass	May 25	Loam and calcareous rubble.
Alopecurus pratensis.	Meadow fox-tail grass .	June 1	Calcareous loam with gravelly subsoil.
Arrhenatherum avenaceum.	Common oat-like grass .	July 17	Forest marble loam.
Avena flavescens . .	Yellow oat-like grass .	June 29	Ditto.
Avena pubescens . .	Downy oat grass . . .	July 11	Dry calcareous loam.
Briza media . . .	Common quaking grass .	June 29	Forest marble.
Bromus erectus . .	Upright brome grass .	,, 23	Calcareous loam.
Bromus mollis . .	Soft brome grass . . .	May 8	Stiff loam.
Cynosurus cristatus .	Crested dog's-tail grass .	June 21	Calcareous loam.
Dactylis glomerata .	Cocksfoot grass . . .	,, 13	Ditto on gravel.
Ditto—second specimen, having the seeds ripe.	. .	July 19	Calcareous loam.
Festuca duriuscula .	Hard fescue grass . .	June 13	Dry calcareous loam.
Holcus lanatus . .	Soft meadow grass . .	,, 29	Calcareous loam.
Hordeum pratense .	Meadow barley . . .	July 11	Ditto on gravel.
Lolium perenne . .	Perennial rye grass or darnel.	June 8	Calcareous rubbly loam.
Lolium italicum . .	Italian rye grass . . .	,, 13	Forest marble loam.
Phleum pratense . .	Meadow cat's-tail . .	. .	. .
Poa annua . . .	Annual meadow grass .	May 28	Loam, with gravelly subsoil.
Poa pratensis . . .	Smooth-stalked meadow grass.	June 11	Dry calcareous loam.
Poa trivialis . . .	Rough stalked meadow grass.	,, 18	Calcareous loam.
Grass, from a water meadow . . .	First crop	Apr. 30	. .
Ditto	Second crop	June 26	. .
. .	Annual rye-grass . . .	June 8	Calcareous rubbly loam.

TABLE II.—ARTIFICIAL GRASSES.

Botanical Name.	Common Name.	Date of Collection, 1849.	Nature of Soil.
Trifolium pratense.	Common cultivated red or broad clover.	June 7	Forest marble tenacious loam.
Trifolium pratense perenne.	Common purple trefoil or clover.	,, 4	Calcareous loam or gravel.
Trifolium incarnatum	Scarlet or Italian clover .	,, 4	Calcareous rubbly loam.
Trifolium medium .	Zigzag clover or cow grass	,, 7	Forest marble tenacious loam.
Ditto—second specimen.	. .	,, 21	Calcareous loam.
Trifolium procumbens	Hop trefoil	,, 13	Dry calcareous loam.
Trifolium repens . .	White trefoil or Dutch clover.	,, 18	Forest marble loam.
Vicia sativa . . .	Common vetch . . .	,, 13	Ditto.
Vicia sepium . . .	Bush vetch	,, 9	Stiff forest marble clay.
Onobrychis sativa .	Sainfoin	,, 8	Dry rubbly loam.
Medicago sativa . .	Purple medick or lucerne	,, 16	Ditto.
Medicago lupulina .	Black medick or nonsuch	,, 6	Calcareous rubbly loam.
Plantago lanceolata .	Ribwort plantain, ribgrass	May 28	Calcareous clay.
Poterium sanguisorbia	Common salad burnet .	,, 28	Ditto.
Poterium millefolium	Yarrow	..	. .

TABLE III.—ANALYSES OF NATURAL GRASSES. (In 100 parts of Grass as removed from the field.)

Name of Plant.	1 Water.	2 Albuminous or Flesh-forming Principles.	3 Fatty Matters.	4 Heat Producing Principles. — Starch, Gum, Sugar, &c.	5 Woody Fibre.	6 Mineral Matter or Ash.	7 Date of Collection.
Anthoxanthum odoratum	80·35	2·05	·67	8·54	7·15	1·24	May 25
Alopecurus pratensis .	80·20	2·44	·52	8·59	6·70	1·55	June 1
Arrhenatherumavenaceum	72·65	3·54	·87	11·21	9·37	2·36	July 17
Avena flavescens . . .	60·40	2·96	1·04	18·66	14·22	2·72	June 29
Avena pubescens . . .	61·50	3·07	·92	19·16	13·34	2·01	July 11
Briza media	51·85	2·93	1·45	22·60	17·00	4·17	June 29
Bromus erectus . . .	59·57	3·78	1·35	33·19		2·11	,, 23
Bromus mollis . . .	76·62	4·05	·47	9·04	8·46	1·36	May 8
Cynosurus cristatus . .	62·73	4·13	1·32	19·64	9·80	2·38	June 21
Dactylis glomerata . .	70·00	4·06	·94	13·30	10·11	1·59	,, 13
Ditto—seeds ripe. . .	52·57	10·93	·74	12·61	20·54	2·61	July 19
Festuca duriuscula . .	69·33	3·70	1·02	12·46	11·83	1·66	June 13
Holcus lanatus . . .	69·70	3·49	1·02	11·92	11·94	1·93	,, 29
Hordeum pratense . .	58·85	4·59	·94	20·05	13·03	2·54	July 11
Lolium perenne . . .	71·43	3·37	·91	12·08	10·06	2·15	June 8
Lolum italicum . . .	75·61	2·45	·80	14·11	4·82	2·21	,, 13
Phleum pratense . . .	57·21	4·86	1·50	22·85	11·32	2·26	. .
Poa annua.	79·14	2·47	·71	10·79	6·30	·59	May 28
Poa pratensis	67·14	3·41	·86	14·15	12·49	1·95	June 11
Poa trivialis	73·60	2·58	·97	10·54	10·11	2·20	,, 18
Grass from a water meadow	87·58	3·22	·81	3·98	3·13	1·28	Apr. 30
Ditto—second crop . .	74·53	2·78	·52	11·17	8·76	2·24	June 26
Annual rye-grass. . .	69·00	2·96	·69	12·89	12·47	1·99	,, 8

Table III. contains the analysis of the principal natural grasses. Column No. 1 gives the proportion of water; No. 2, the *flesh-forming principles;* No. 3, the *fat-producing principles;* No. 4, the *heat-giving principles;* No. 5, the woody matter; No. 6, the ash. To these I have added a seventh column, of the date of collection, to facilitate a comparison of the latter with the percentage of water.

The first column of this Table exhibits numbers which differ very much from each other. Whilst in some cases the percentage of water is as high as 80, in others it only amounts to 60; in one instance (Briza media) being as low as 51. I do not here mention the second sample of Dactylis glomerata, which was taken when fully ripe, because this must necessarily be excepted.

The proportion of water is evidently connected with the period at which the grass comes into flower, the earliest grasses being generally the most succulent, although a careful examination of the Table will show that this is not always the case. Thus the specimens Briza media and Holcus lanatus, both gathered on the 29th of June, contain respectively in round numbers 52 and 70 per cent. of water.

The proportion of water in a plant becomes interesting chiefly when it is considered as influencing the proportion of dry matter or actual feeding material of the plant. Thus, for instance, the quantity of dry or solid matter in 100 parts of Anthoxanthum odoratum or Alopecurus pratensis is 20 parts; whilst in Avena flavescens or pubescens it reaches as much as 39 or 40 parts. The immediate interest of this circumstance to the farmer is, that in judging of the quantity of hay which will be produced from a meadow, he must take into account the nature of the grasses composing it, since it is plain that in the instances mentioned a given weight of one kind of grass will produce twice as much hay as another.

In looking down the colomns of this Table, especially Nos. 1, 2, 3, and 4, which are most important, very great differences will be seen; the albuminous matters, for instance, being in some cases double what they are in others. In some instances these are differences really in the proportion of the various principles in relation to each other; but an apparent variation is very often produced by the greater or less amount of water contained in the plant. Such differences are real so far as the comparison of the fresh-cut grass is concerned, but they in many cases cease to exist when the grasses, being made into hay, are carried to the same point of dryness.

I believe this latter to be the most important point of view, both practically and scientifically, and I shall therefore reserve

any further remarks on this head until the composition of the dry grasses is before us.

The Table which follows (No. IV.) gives the analysis of the artificial grasses and clovers, as taken from the field.

TABLE IV.—ANALYSES OF ARTIFICIAL GRASSES. (In 100 parts as taken from the field.)

Name of Plant.	1 Water.	2 Albuminous or Flesh-forming Principles.	3 Fatty Matters.	4 Heat Producing Principles. Starch, Gum, Sugar, &c.	5 Woody Fibre.	6 Mineral Matter or Ash.	7 Date of Collection.
Trifolium pratense . . .	81·01	4·27	·69	8·45	3·76	1·82	June 7
Trifolium pratense perenne .	81·05	3·64	·78	8·04	4·91	1·58	,, 4
Trifolium incarnatum . .	82·14	2·96	·67	6·70	5·78	1·75	,, 4
Trifolium medium . . .	74·10	6·30	·92	9·42	6·25	3·01	,, 7
Ditto—second specimen . .	77·57	4·22	1·07	11·14	4·23	1·77	,, 21
Trifolium procumbens . .	83·48	3·39	·77	7·25	3·74	1·37	,, 13
Trifolium repens	79·71	3·80	·89	8·14	5·38	2·08	,, 18
Vicia sativa	82·90	4·04	·52	6·75	4·68	1·11	,, 13
Vicia sepium	79·90	4·64	·58	6·66	6·24	1·98	,, 9
Onobrychis sativa . . .	76·64	4·32	·70	10·73	5·77	1·84	,, 8
Medicago lupulina . . .	76·80	5·70	·94	7·73	6·32	2·51	,, 6
Plantago lanceolata . . .	84·75	2·18	·56	6·06	5·10	1·35	May 28
Poterium sanguisorbia . .	85·56	2·42	·58	6·85	3·44	1·15	,, 28
Medicago sativa	69·95	3·83	·82	13·62	8·74	3·04	June 16

The percentage of water is in these grasses, on the average, higher than in the natural grasses; but, in spite of this circumstance, the column appropriated to albuminous matters exhibits numbers which exceed very considerably those in the previous Table. In other words, weight for weight, even when fresh cut, the "artificial" grasses contain a much larger proportion of flesh-forming principles. How much this difference is increased when the samples are compared in the state of hay will be seen when we give, as we shall now do, the numbers which represent the composition of the various grasses when dry.

The Tables which follow (Nos. V. and VI.) give the composition of the whole series after drying at 212° of Fahrenheit, until all the moisture of the grass is expelled.

There are many points of great interest brought out by these Tables, and I might perhaps be pardoned for employing the numbers they contain as tending to confirm or refute some of the most important doctrines extant on the subject, both of vegetable and animal nutrition. This, however, is not my object: I look upon these analyses as an addition to our previous knowledge—a contribution, in fact, to the data upon which all philosophical reasoning should be built; but whilst I should of course

TABLE V.—ANALYSES OF NATURAL GRASSES. (In 100 parts of the Grass dried at 212° Fahrenheit.)

Name of Plant.	2 Albuminous or Flesh-forming Principles.	3 Fatty Matters.	4 Heat Producing Principles. Starch, Gum, Sugar, &c.	5 Woody Fibre.	6 Mineral Matter or Ash.
Anthoxanthum odoratum	10·43	3·41	43·48	36·36	6·32
Alopecurus pratensis	12·32	2·92	43·12	33·83	7·81
Arrhenatherum avenaceum	12·95	3·19	38·03	34·24	11·59
Avena flavescens	7·48	2·61	47·08	35·95	6·88
Avena pubescens	7·97	2·39	49·78	34·64	5·22
Briza media	6·08	3·01	46·95	35·30	8·66
Bromus erectus	9·44	3·33	82·02		5·21
Bromus mollis	17·29	2·11	38·66	36·12	5·82
Cynosurus cristatus	11·08	3·54	52·64	26·36	6·38
Dactylis glomerata	13·53	3·14	44·32	33·70	5·31
Ditto—seeds ripe	23·08	1·56	26·53	43·32	5·51
Festuca duriuscula	12·10	3·34	40·43	38·71	5·42
Holcus lanatus	11·52	3·56	39·25	39·30	6·37
Hordeum pratense	11·17	2·30	46·68	31·67	6·18
Lolium perenne	11·85	3·17	42·24	35·20	7·54
Lolium italicum	10·10	3·27	57·82	19·76	9·05
Phleum pratense	11·36	3·55	53·35	26·46	5·28
Poa annua	11·83	3·42	51·70	30·22	2·83
Poa pratensis	10·35	2·63	43·06	38·02	5·94
Poa trivialis	9·80	3·67	40·17	38·03	8·33
Grass from water meadow	25·91	6·53	32·05	25·14	10·37
Ditto—second crop	10·92	2·06	43·90	34·30	8·82

TABLE VI.—ANALYSES OF ARTIFICIAL GRASSES. (In 100 parts of the Grass dried at 212° Fahrenheit.)

Name of Plant.	2 Albuminous or Flesh-forming Principles.	3 Fatty Matters.	4 Heat Producing Principles. Starch. Gum. Sugar, &c.	5 Woody Fibre.	6 Mineral Matter or Ash.
Trifolium pratense	22·55	3·67	44·47	19·75	9·56
Trifolium pratense perenne	19·18	4·09	42·42	25·96	8·35
Trifolium incarnatum	16·60	3·73	37·50	32·39	9·78
Trifolium medium	24·33	3·57	36·36	24·14	11·60
Ditto—second specimen	18·77	4·77	49·65	18·84	7·97
Trifolium procumbens	20·48	4·67	43·86	22·66	8·33
Trifolium repens	18·76	4·38	40·04	26·53	10·29
Vicia sativa	23·61	3·06	39·45	27·38	6·50
Vicia sepium	23·08	2·88	33·15	31·04	9·85
Onobrychis sativa	18·45	3·01	45·96	24·71	7·87
Medicago lupulina	24·60	4·06	33·31	27·19	10·84
Plantago lanceolata	14·29	3·67	40·29	33·07	8·68
Poterium sanguisorbia	16·75	4·01	47·40	23·87	7·97
Achillea millefolium	10·34	2·51	45·46	32·69	9·00
Medicago sativa	12·76	2·76	40·16	34·21	10·11

be the last to under-rate their value, I do not consider that such data are sufficient in themselves to settle the controverted points; and indeed, however much may be the labour and time bestowed upon them, one such set of results is inadequate to convince us that very considerable variations in composition might not be found in the same plants under different circumstances of soil and climate. But at the same time, whilst the trifling differences in composition between specimens of one and another kind of grass, as shown in these Tables, will not be insisted upon, we have fairly a right to call attention to those broad lines of distinction which are to be found there. I shall, however, do this very shortly, leaving to the reader, who cares to do so, to study for himself the results which I have obtained, and to see how far they agree with his practical experience of the feeding and fattening value of the different grasses examined.

The two last Tables give the composition of the grasses in the *dry state.* The numbers must therefore be somewhat modified for them when in the state of hay; for, however dry it may appear, no grass can be made absolutely dry without artificial heat. The usual proportion of moisture in well-made hay I believe to be about 16 per cent.; and I have found about this quantity in several samples; and a grass that has been dried artificially will in the open air acquire about this degree of moisture. It would have occupied space unnecessarily to have given the numbers which would apply to the grasses in the state of hay, and the calculation can be easily made by those who care for it: from the percentage of albuminous or fatty matter in the dry specimen about one-sixth is to be deducted to ascertain the quantity present in the hay. The numbers are, however, strictly comparable with each other.

We will first advert to Table V.—that of the natural grasses in the dry state—leaving out of the question for the present the water-meadow grass and the Dactylis glomerata, of which the seeds are ripened; we find the following numbers to represent the lowest, highest, and average quantities per cent. of the different principles in the specimens of natural grasses examined:—

	Lowest.	Highest.	Average.
Flesh-forming principles . .	6·08	17·29	10·98
Fat-producing principles . .	2·11	3·67	3·08
Heat-giving principles . . .	38·03	57·82	45·57

These difference are very great, and if composition influences feeding properties, as it must as certainly as effect of any kind follows cause, the value of the different grasses must be very variable. I would, however, guard the farmer who has a practical acquaintance with this matter from judging hastily that the

theoretical equivalents of nutritive value here shown are not in accordance with experience. It is well to remember that many of those grasses which are highly valued are so valued not because of their intrinsic worth as feeding agents, but because they present themselves at a time when they are very much wanted—that is to say, in early spring. The most remarkable specimens in this Table are the water-meadow grass (first crop) and the Dactylis glomerata (with seeds ripe). Both in the quantity of nitrogen and fatty matters the water-meadow grass nearly doubles the other grasses in the Table. This meadow was composed principally of the grasses Poa trivialis, Holcus lanatus, Hordeum pratense, Avena pratensis, Lolium perenne, &c.; in none of which do we see the peculiarity which unitedly they show in this meadow. Are we to attribute the high proportions of fat and flesh-forming principles to the action of the water in irrigation? If so, we have indeed in it a most important and powerful agent. The other instance named (the Dactylis glomerata) shows us how large a portion of nitrogen is accumulated in the plant as it progresses to maturity; and whatever view we may take of this circumstance in relation to the nutritive properties of a plant, we cannot doubt that it is then that the soil most suffers from the drain which is made upon it.

The Italian rye-grass (Lolium italicum) is remarkable for the small quantity of useless matter (woody fibre), the large proportion of soluble carbonaceous matters (starch, gum, &c.), and the moderate proportion of albuminous constituents. From the well-known value of Italian rye-grass the composition is a matter of interest.

We turn now for an instant to Table VI.

In these, the artificial grasses, we find the proportions of the different principles varying to the following extent:—

	Lowest.	Highest.	Average.
Flesh-forming principles . .	10·34	24·60	19·03
Fat-producing principles . .	2·51	4·77	3·65
Heat-giving principles . . .	33·15	49·65	41·29

The chief peculiarities of this series, in comparison with those of the natural grasses, consist in the much higher proportion (in many cases more than double) of albuminous matters, and of a certain, though less evident, advantage in the quantity of fatty matters; whilst the heat-giving principles remaining nearly the same, the quantity of woody matter is necessarily much reduced. As a proof of the high value which theoretically we should place upon the artificial grasses, I may remark that in the dry state they equal peas or beans in nitrogenous matter, and considerably excel them in the proportion of fatty matter.

I will take leave of these Tables by remarking that, if the

view which gives a prominent value, for feeding purposes, to albuminous matters in large proportion over the non-nitrogenous portions of plants be correct, the "artificial" are far more nutritive that the natural grasses. But, as I before said, these results were not intended as a peg to hang an argument upon, either on one side or the other, and for the present I am content to offer them as a contribution to the chemistry of vegetation, without further argument or deduction. The following are analyses of a few weeds:—

TABLE VII.—ON THE SPECIMEN AS COLLECTED.

Name of Plant.	Date of Collection.	Water.	Albuminous Matter.	Fatty Matter.	Heat Producing Principles.	Woody Fibre.	Ash.
Centaurea nigra . . .	July 24	69·05	3·03	·641	14·28	10·84	2·16
Crysanthemum leucanthemum.	June 23	71·85	2·12	·999	12·64	10·51	1·85
Juncus glaucus . . .	July 11	64·05	2·38	1·121	16·48	13·82	2·15
Papaver rhœas . . .	,, 2	81·00	1·71	·883	7·20	6·08	3·13
Ranunculus acris . . .	June 13	88·15	1·18	·507	6·26	3·00	·91
Rumex acetosa . . .	July 4	75·37	1·90	·545	7·62	13·04	1·51
Sinapis arvensis . . .	June 29	85·31	1·93	·393	6·95	4·40	1·02

TABLE VIII.—ON THE DRY SPECIMEN.

Name of Plant.	Albuminous Matter.	Fatty Matter.	Heat Producing Principles.	Woody Fibre.	Ash.
Centaurea nigra	9·79	2·07	46·09	35·04	7·01
Crysanthemum leucanthemum .	7·53	3·49	45·02	37·33	6·63
Juncus glaucus	6·61	3·12	45·81	38·46	6·00
Papaver rhœas	9·02	4·65	41·43	28·71	16·49
Ranunculus acris	9·98	4·28	52·69	25·34	7·71
Rumex acetosa	7·71	2·19	46·82	37·16	6·12
Sinapis arvensis	13·03	2·67	47·30	30·00	7·00

On the whole these weeds contain less nitrogen than the useful grasses—a circumstance which may in part account for the rapidity with which they spring up even in poor soils, and the difficulty of eradicating them.

APPENDIX.

The methods of analysis adopted in this investigation were as follows:—

1. For the determination of water, the plants when removed from the field were carefully weighed; they were then inclosed in tin cases, and forwarded immediately by railway to London. The entire samples (of several pounds in most cases) were then

introduced into a drying-oven, the temperature of which would vary between 120° and 160° Fahr., and in which they remained for two or three weeks. A portion of each sample was in each case dried in a water-bath, but it was found that at a temperature of 212° further diminution of weight seldom occurred.

The samples were then broken up into fine powder and passed through a sieve of forty holes to the inch (every part of the grass being of course made to pass through the sieve), and preserved for analysis.

2. For the determination of albuminous matter, a portion of the grass dried anew in the water-bath was burned with soda-lime in the usual way, the nitrogen being weighed as platinum salt. The quantity of albuminous matter was calculated from the nitrogen upon the datum that 15·75 per cent. of this element represents 100 parts of the different albuminous constituents—this being the *average* percentage of nitrogen in these constituents.

I am quite aware that an objection has been raised against this method of determining albuminous matter, and one that deserves some consideration. Dr. Vöelcker, I believe, first pointed out that the juices of vegetables contained ammoniacal salts, which in this method of analysis would tend to increase the quantity of nitrogen, and therefore to exaggerate the proportion of albuminous matter as calculated from it. In the first place I should state that the analyses now given were made before this question was opened; consequently, however much weight I might be disposed to attach to the objections, I am not in a position to modify my methods in accordance with it. In the second it does not appear to me to be of any great importance in the present instance.

Dr. Vöelcker states (Report of the British Association for 1850—Transactions of the Sections, p. 64), that in fungi (or Agarics) examined by him, one-third of the nitrogen present existed in the state of ammoniacal salts. Probably, of all the vegetables he could have selected, none would have been so likely to give this result as the one in question, from the rapidity of its growth, and from the fact that this growth takes place in great part when the chief agents of *elaboration*—light and heat—are withdrawn. But, without denying the importance of Dr. Vöelcker's observations on this subject, which were not confined to the mushroom, I am induced to believe that such a cause of error could not materially affect the analyses which are now published, and those very numerous results of other chemists which have been conducted on the same principle. If ammoniacal salts in the plant are supposed to cause a serious error in the estimation of nitrogen, that error must be common *to all* the samples of grasses examined in a degree only influenced by the

quantity of water present in them—that is to say, that a grass containing 60 per cent. of water would furnish one-fourth less only of ammoniacal salts than one in which the water was 80 per cent.

With this modification, then, the source of error now under discussion would equally apply to all the samples, and would not materially affect their *relative* nutritive value, which it has been the chief object of this paper to establish.

Those readers, however, who will take the trouble to examine the subject will see that whilst the differences in albuminous matter in the grasses are far too great to be due to such a cause, it is not really the case (at all events as a rule) that the highest percentage of moisture is accompanied by the largest proportion of albuminous matter.

Not denying, therefore, as I said before, the necessity of bearing in mind the objection existing to the determination of albuminous matter by that of the nitrogen (which, however, is *practically* still likely to be the most correct, because by far the most simple way of ascertaining the proportion of these matters), I do not, for the reasons stated, attach much weight to it in the present instance.

3. The determination of fatty matters in the dry grass was digested in hot ether, and repeatedly washed with the same liquid. The ethereal solution was then distilled in a globular flask in the water-bath, and the residual oil and fatty matters weighed repeatedly till the weights remained constant.

The numbers in Table IX. were obtained in the estimation of the nitrogen and fatty matters of the grasses in each instance where a second analysis was made.

4. and 5. The starch, gum, sugar, &c., and the woody fibre, were determined in this way.

A given weight of the grass was digested with heat in a moderately strong solution of caustic potash; the liquid was decanted off, and a fresh solution of potash employed. The insoluble matter was thrown upon a filter and washed with boiling water till the liquid coming through was pure water. It was believed that in this way gum, sugar, starch, &c., together with the albuminous matters, were dissolved, and the insoluble residue was woody fire with a certain amount of ash. The insoluble matter was carefully dried, and after being weighed was burned, the residue being the mineral matter which was deducted.

6. The ash was obtained in the usual way by burning the grass.

It is plain that we have in the above methods the data for calculating the percentage of each of the classes of substances enumerated above.

TABLE IX.—ON THE DRIED SPECIMENS.

Names of Plants.	Nitrogen.			Oil.		
	1st Determination.	2nd Determination.	Mean.	1st Determination.	2nd Determination.	Mean.
Trifolium pratense perenne	3·022	3·019	3·020	4·088	4·096	4·092
Trifolium incarnatum	2·628	2·582	2·615	3·736	3·724	3·730
Trifolium medium	3·857	3·813	3·835	3·577	3·555	3·566
Trifolium procumbens	3·188	3·268	3·228	4·716	4·617	4·666
Trifolium pratense	3·602	3·500	3·551	3·632	3·710	3·671
Trifolium repens	2·937	2·967	2·952	3·811	4·013	3·912
Trifolium medium—second specimen.	3·002	2·916	2·959	4·491	5·044	4·768
Vicia sativa	3·752	3·690	3·721	3·102	3·029	3·065
Medicago lupulina	3·891	3·860	3·876	4·011	4·110	4·060
Vicia sepium	3·644	3·634	3·639	2·800	2·990	2·895
Anthoxanthum odoratum	1·680	1·610	1·645	3·430	3·400	3·415
Poterium sanguisorbia	2·840	2·454	2·647	3·870	4·114	3·992
Plantago lanceolata	2·300	2·200	2·250	3·700	3·670	3·685
Alopecurus pratensis	1·943	1·940	1·941	2·675	2·620	2·647
Poa annua	1·839	1·890	1·864	3·412	3·425	3·418
Poa pratensis	1·633	1·634	1·633	2·659	2·596	2·627
Annual rye grass	1·505	1·500	1·502	2·460	2·000	2·230
Poa trivialis	1·508	1·580	1·544	3·664	3·668	3·666
Onobrychis sativa	2·872	2·942	2·907	3·087	2·930	3·008
Avena pubescens	1·265	1·250	1·257	2·294	2·467	2·380
Bromus mollis	2·710	2·740	2·725	2·144	2·090	2·112
Dactylis glomerata	2·100	2·168	2·134	3·289	3·000	3·144
Ditto—seeds ripe	3·538	3·734	3·636	1·545	1·573	1·564
Lolium perenne	1·880	1·850	1·865	3·233	3·108	3·170
Festuca duriuscula	1·924	1·895	1·909	3·166	3·511	3·338
Arrhenatherum avenaceum	2·005	2·075	2·040	3·165	3·219	3·192
Lolium italicum	1·613	1·571	1·592	3·064	3·472	3·273
Cynosurus cristatus	1·842	1·647	1·744	3·585	3·500	3·542
Chrysanthemum leucanthemum.	1·180	1·192	1·186	3·283	3·714	3·498
Briza media	1·014	·900	·957	3·046	2·970	3·008
Avena flavescens	1·186	1·170	1·178	2·546	2·680	2·613
Holcus lanatus	1·818	1·813	1·815	3·367	3·710	3·359
Rumex acetosa	1·235	1·192	1·213	2·035	2·357	2·196
Sinapis arvensis	2·080	2·113	2·051	2·627	2·728	2·677
Bromus erectus	1·488	1·465	1·476	3·425	3·129	3·327

XIII.—*Flax, its Treatment, Agricultural and Technical.*

By John Wilson, F.R.S.E., F.G.S., &c.

Flax belongs to the order Lineæ in the Natural System, which is equivalent to the order Pentandria Pentagynia in the Linnæan, a small order containing, according to Lindley,* 3 genera and 90 species, which are met with scattered irregularly over the greater part of the world. Europe, North Africa, and North and South America seem to be its principal stations; individual members, however, are found in India, New Zealand, Australia, and other countries. Its native country appears to be a matter of question amongst botanists, as it is found growing wild in most countries where the physical conditions are suited to its cultivation. The general opinion, however, inclines towards ascribing it to the East. Be that as it may, this disposition to suit itself to such a vast range of soils and climates is of infinite importance to man, as it enables him to avail himself of the advantages resulting from its cultivation to a far greater extent than he otherwise would be able to do. The botanical characters of the order are well marked, and render it easily distinguishable from all others. It possesses 4, or more commonly 5, sepals; the petals are always equal in number with the sepals; the stamens are also equal in number, and alternate with them; it has 5 stigmas and an ovarium with 10 divisions, or rather 5 perfect cells, which are separated again by an imperfect partition, extending from its outer wall. In each of these cells is found a single seed, of a flattened oval shape, and of a more or less dark brown colour—mucilaginous to the taste, and containing a large proportion of a brownish yellow oil, known as linseed oil. This oil is readily obtained by pressure from the seed, the residuum being the well-known feeding substance termed linseed cake.

The members of this order, generally, are remarkable for the tenacity of their fibres, the elegance of their shapes, the beauty of their flowers, which are blue, red, or white,† and the emollient and demulcent properties of their seeds. All are harmless, some possessing slight medicinal action, in others even this is absent. Of these we may cite the Linum Catharticum, a very common weed, whose leaves contain properties of a purgative character, and the L. selaginoides, which is accounted in South America of great use, both as a mild aperient and as a tonic. Probably these

* Vegetable Kingdom, p. 485.

† M. Brogniart considers that white varieties often exhibit a marked difference in the colouring of the leaves, and suggests that a modification may also exist in the tissues of the stems. M. L. Vilmorin is at present experimenting upon the cultivation of white varieties of flax. So far, he considers the fibre to be of a coarser quality.—*Annales de l'Agriculture Française. Fev.* 1853.

properties pervade the whole order, but have not been remarked in the cultivated flax. Several of its members are plentifully met with in this country as weeds: the Linum Catharticum is very common on poor lands; the L. perenne (or Siberian flax), usually on chalk formations; the L. usitatissimum on cultivated soils; and more rarely the L. angustifolium, which is met with on sandy and barren pastures, principally near the sea; while the Radiola is well known to all botanists as being met with in moist and boggy places.

Although there are many kinds of flax known to botanists as possessing fibres suitable for textile purposes, the L. usitatissimum appears to be the only one which has been employed in cultivation. Of this Dr. Lindley tells us there are two very different forms,* namely,—1. The L. humile or crepitans (the Springlein or Klanglein of the Germans), a plant somewhat shorter and more inclined to branch than the other, and possessing larger capsules, twice as long as the calyx, which burst with considerable elasticity when ripe; its seeds, too, are both larger and of a paler colour. 2. The L. usitatissimum, or true winter flax (Winterlein of the Germans), which has smaller capsules, scarcely longer than the calyx, not bursting with elasticity, but firmly retaining their seeds, which are of a dark brown colour. These distinctions do not seem to be very well understood in this country, though they certainly are of some practical importance.

In the market we frequently meet with this full-bodied light-coloured seed, and it is generally considered to be the produce of flax harvested before the straw was quite ripe; whereas it is the mature produce of a different variety, suitable for spring sowing, and probably having a more rapid growth than the L. usitatissimum or winter flax. In the foreign department of the Exhibition in 1851 samples of both were seen in several places. In Austria and North Europe, where the winters are severe and the snow lies too long on the ground to admit of early tillage in the spring, the Winterlein is extensively used and sown in the autumn; the summer season being too short and too hot to admit of the successful cultivation of the Springlein. With us the custom is to sow in the spring, though no doubt in some of our northern districts, where the ground cannot be got ready sufficiently early in the spring, flax could be advantageously cultivated if sown in the previous autumn.

The important services which flax has rendered to man has secured for it a record from the earliest times. In the Bible we find frequent mention made of it both as flax and in its manu-

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* Encyclop. of Agric.—*Blackie and Co.*

factured state as linen; and on various Egyptian monuments the plant and the preparation of its fibres are represented.

In the Book of Exodus* it is noted as one of the principal crops grown in Egypt. Being one of the chief sources whence the Egyptians derived articles of comfort and luxury, it was selected by the Almighty for destruction when he sent the plague of hail as a judgment on that people. From the Book of Joshua† we find that flax was cultivated in Palestine, when it is stated that Rahab used flax to hide the spies sent by Joshua to examine Jericho.

In the history of Samson,‡ also, reference is made to flax as being a well-known crop. Many allusions are made to it in its prepared and manufactured state, both in the Old and in the New Testaments,§ all of which refer to the same plant we now term flax, and which is the same as that known by the Hebrew name "Pishtah," and by the Greek name "Linon."

We have also ample records of its cultivation in the days of Greece and Rome. Columella ‖ speaks of it as a hurtful crop, which exhausts the land, and which he says "should not be grown unless there is reason to expect a very great crop, and one is tempted by a very great price." Virgil ¶ joins it with oats and poppies, and says "that all these exhaust the soil." Palladius** expresses the same opinion. Pliny,†† while condemning it as a crop, moralizes over it and asks, "what greater miracle than that there should be a plant which makes Egypt approach nearer to Italy; that there should grow from so small a seed, and upon so slender and short a stalk, that which, as it were, carries the globe itself to and fro." By this we must infer that its use both in the shape of ropes and sailcloth was well known; and in the succeeding chapters we are informed that many nations used it when woven into linen as wearing apparel. Pliny is the only author who enters minutely into the details, both of its cultivation and subsequent preparation. He speaks chiefly of spring-sown flax. According to the other authors flax was sown usually in the autumn, in the months of October and November, when 8 *modii*‡‡ of seed were sown upon the *jugerum*, whereas 10 were required for the spring sown, the land having been previously manured. The harvesting and

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* Ex. ix., v. 31, 32. † Josh. ii., v. 6. ‡ Judges xv., v. 14.

§ Prov. xxxi., v. 13–19; Is. xix., v. 9; 1 Sam. ii., v. 18; 2 Sam. vi., v. 14; Jer. xiii., v. 1; 1 Kings, x., v. 28; 2 Chron. i., v. 16; Ezek. xiv., v. 3; Hos. ii., v. 5–9, and other places.

‖ Columella, lib. ii., cap. x.

¶ Georg., lib. i., v. 77. "Urit enim lini campum seges, urit avenæ."

** Palladius, lib. xi., cap. ii. †† Pliny, Nat. Hist., lib. xix, proœm.

‡‡ The Roman modus was about the same as the English peck. The jugerum was equal to ·618 of an acre.

steeping appear to have been carried on much the same as in later times; the scutching was performed by beating the steeped straw upon a stone with a peculiar mallet, and then drawing it through iron heckles. The tow was of little use except as wicks for candles. The "boon," or "shove," was used as fuel, and the cleaned fibre was bleached by being watered and exposed in the ordinary manner. He describes Spanish flax as being of very fine quality; and mentions another sort, which was cultivated in Campania, whose fibres were so fine and so tough that nets were made of them to entangle wild boars, and so hard as to resist even the stroke of a sword:—"I have seen," he says, "these snares of such fineness as to pass with the ropes at the upper and under side through the ring of a man's finger; one man being able to carry as many of them as would encircle the hunting ground. Nor is this the most extraordinary part, for each strand of them consisted of 150 threads." He relates also that, in the temple of Minerva in Rhodes, the breastplate of Amasis, a King of Egypt, was found made of this net, each strand consisting of 365 threads. This was taken by the Consul Mutianus to Rome, where it was exhibited at the time Pliny wrote, as a specimen both of fineness and strength of fibre, and also of skill in spinning and twisting yarn. Certainly modern times have nothing to compare with it.

The absence of all agricultural records after the fall of the Roman Empire leaves a blank in our history until towards the end of the 12th century, when we gather, from papers of that period, that flax was in considerable cultivation in this country. As the country became more settled, and civilization advanced, the use of linen became more general, and we find that, in 1532 (Hen. VIII.), an Act of Parliament was passed requiring that every person occupying land fit for tillage should, for each quantity of 60 acres, sow at least 1 rood of it in flax each year. This quantity was increased to an acre in 1562 (Elizabeth) under pain of a penalty. In 1691 (William and Mary), with a view to encourage its cultivation as much as possible, an Act was passed fixing the tithe on flax at only 4*s.* per acre. In 1713 (Anne 12, cap. 16) a bounty of 1*d.* per ell was allowed on the exportation of home-made sailcloth; and in 1806 (George III. 46, cap. 46) a bounty was offered for the importation of flax and hemp from the American Colonies.

These references tend to show that flax has always occupied the attention of different countries, and in our own they would lead us to infer that, although probably the proportion grown formerly was superior to that of late years, still the demand was always greater than the supply. It has been said by the advocates of flax growing, that whereas nine-tenths of the inhabitants

of the civilized world are supplied with clothing either from the animal or vegetable kingdoms,—either wool or silk,—the one the produce of temperate, the other of warmer climates; or cotton and flax, the first requiring the moisture and heat of tropical countries, the other a native of our own, delighting in our temperate climate; still we have to depend mainly on foreign lands for the supply we need, and for which our own are so peculiarly adapted. This is very true; and no doubt now that the question of exhaustion of the soil is set at rest by the true explanation which science has placed in our hands; * and increased cultivation and observation have enabled us to decide upon the character of the soil best suited, mechanically as well as chemically, for its growth; we shall acknowledge the demand made upon us for its production, and receive it into our ordinary rotations without any of those terrors of subsequent poverty to the soil with which it has hitherto been accompanied.

Flax, fortunately, has a very wide range of soils:† sands, sandy loams, light and heavy clays, gravels, chalk, marls, alluvial soils,

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* Some experiments were made a short time since, by Dr. Hodges, for the purpose of ascertaining the relative proportions of the produce of flax, and also the distribution of the inorganic matter in them. The flax employed had been steeped in the ordinary way, and was found to contain 1·73 of ash. Of this air-dried straw 4000 lbs. weight were taken, which produced—

Of dressed fibre	500 lbs.
fine tow	132
coarse tow	192
Of fibre in all	824 lbs.

These products contained—

In the dressed flax	4·48 lbs. of ash.
fine tow	2·08 ,,
coarse tow	2·56 ,,

Or in the whole of the fibre . . . 9·12 lbs. of inorganic matter; so that 59·08 lbs., which the crop had withdrawn from the soil, remained in the useless portions, while only 9·12 lbs. were carried off in the dressed fibre.

†	Irish.			Belgian.			
	1.	2.	3.	4.	5.	6.	7.
Silica	73·72	69·41	64·93	92·78	87·04	91·8	86·47
Alumina	6·65	5·77	8·97	1·11	1·52	1·22	1·57
Water	7·57	11·48	8·62	2·03	3·8	1·85	2·92
Organic Matter	4·86	6·67	9·41	2·74	4·48	3·45	5·78
	Londonderry and Tyrone.			Dussel, near Antwerp.	Courtrai.	Lakeren.	Ypres.

Prize Essay on Flax, by James M'Adam, jun. R.A.S. Journal, vol. viii.

peat, and reclaimed marsh lands are all seen, under ordinary circumstances, to produce a crop. The sandy loams and the alluvial soils, natural as well as artificial (warp lands), however, appear to be the best suited to its cultivation. In Ireland large crops are obtained on peat bogs, lands with a clay substratum. The plant needs an open soil, through which the water may freely percolate, as its roots are of a fibrous nature, and extend laterally and vertically to a considerable distance (2 or 3 feet). All the conditions required for its successful cultivation are, that the soil be deep, in good heart and in good tilth, well drained and free from weeds ; if these exist we may, under ordinary circumstances, expect a good crop. Owing to the rapid growth of the plant, and the consequent shortness of time it occupies the land, it offers many opportunities to the grower, and admits of more changes in the rotation than most of the other farm crops. These rotations vary in almost every locality, and must necessarily be influenced materially by the soil, the climate, and the general cultivation in relation to the markets of the district. As these rotations are subject to so many modifications, it is unnecessary to occupy your time with describing them now.* I would only mention that, under ordinary circumstances, it is found that the crop succeeds best after corn, or upon recently broken up ground ; and that the crop is not generally so remunerative when it follows turnips, potatoes, or other root crops. The large quantity of organic matter usually applied to such crops has a tendency to make the flax grow rank ; and although a large crop is frequently obtained, the quality is not so good, and the plant is more liable to sustain injury both from wind and wet at the time approaching its maturity.

The mode of cultivation is too well known to need more than a passing observation. The condition and tilth of the soil must be secured ; about two bushels of cleaned seed to the acre should be sown broadcast by the hand or by the broadcast barrow ; it should then be covered in by a pair of fine harrows, and a light roller run over it completes the operation. The month of April is the usual time for getting in the seed, but I am much inclined to think that flax might be grown advantageously in many late districts by being sown in the autumn.

After being properly got in the only care it requires is weeding. It is important that this be done in a careful and effective manner, as the value of the crop depends materially upon its cleanness. The harvest operations differ slightly from the usual crops ; the proper time is determined by the colour of the straw and of the seed. Flax is always pulled up by the roots ; these

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* See Essay on Flax.—R.A.S. Journal, vol. viii.

handfulls are usually laid across each other, and subsequently bound up into small sheaves; these are set up in circular stooks, the butts of each being spread out as much as possible, to allow the air to have free access to them; there they remain until sufficiently dried, they are then either stacked in the field or at the homestead; or the seed is separated at once, and then merely the stem or straw stacked. Many different modes both of stacking and separating the seeds exist; probably the cheapest and most efficient is to pass the straw through plain rollers, which crush the capsule, and let the straw pass through uninjured. The seed is separated from the capsule or "boll" by winnowing, and the straw remains to be stacked in the usual way. Under favourable circumstances we may expect an average crop to produce from 30 to 40 cwts. of straw and 16 bushels of seed to the acre.

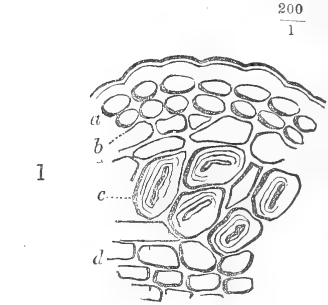
The crop now becomes divided; the one portion is directly serviceable to the farmer as a valuable feeding substance; the other, the straw, is comparatively of little value until it has undergone certain processes by which its character is entirely changed. These require a series of operations quite different from those of the farm, and, in fact, constitute a distinct branch of the flax industry, intermediate between the grower of the straw and the consumer of its prepared fibre, the spinner. This division of labour greatly benefits the grower, as supplying a constant market for an article which a well-organized establishment can dispose of far more beneficially than he could do at home, with imperfect means, and too often, imperfect knowledge.

Before describing these various processes let us consider their object, and the nature or composition of the substance they have to treat. The object may be given in a few words,—the separation of the fibrous from the other portions of the straw. If we take a portion of straw, break it, and carefully examine it, it will be found to consist of three distinct parts:—the centre is occupied by a substance composed of cellular tissue, in appearance like wood, this is usually called the "shove" or "boon;" round this is a tubular sheath composed of bundles of long and tough fibres, cohering firmly together, the whole structure being cemented together by an azotized compound, and enveloped by a thin and delicate bark and skin. The structural arrangement of the stem of the flax plant is beautifully described by Schacht, from whose admirable treatise, Die Pflanzenzelle,* the accompanying plate has been obtained. If a piece of the dried straw be rubbed between the fingers the bark is immediately removed,

* Physiologische Botanik, Die Pflanzenzelle, von Dr. Schacht. Berlin, 1852.

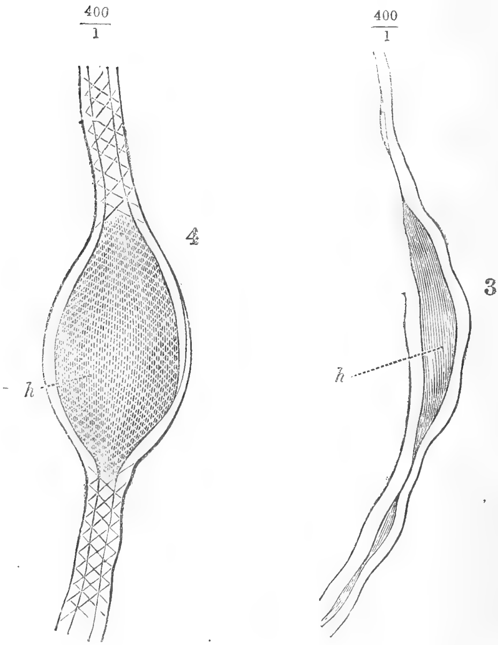
and the fibrous portions are more or less readily detached from the woody centre. These fibrous portions being composed of bundles of very delicate filaments may be split up into almost any degree of fineness, according to the process adopted. Now

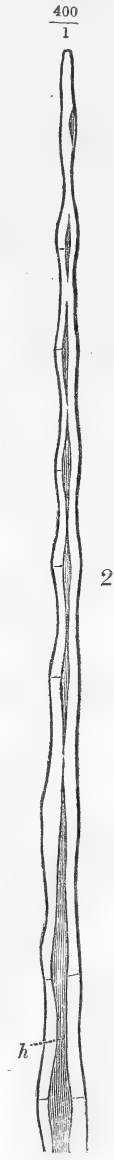
Sections of Flax, Straw, and Fibre.



1. Transverse Section of Straw.

a. Epidermis. *c.* Fibres.
b. Bark. *d.* Shove, or Woody Centre.





2, 3, and 4. Longitudinal Sections of Fibres—*h, h, h,* Cavities.
2 and 3. Ordinary Fibres.
4. Rarer kind.

these various processes differ very much, both in their principles and in their mode of separating the fibre from the other portions of the plant. They may, however, be all classed under two heads,—the *mechanical*, in which the operations are conducted in a *dry* state; and the *chemical*, in which *moisture* is more or less necessary. In the first the object is obtained by the various parts being mechanically separated from each other; in the latter the plant itself is disintegrated, either by the action of fermentation, which destroys, or of some solvent, which abstracts, the cementing matter by which its parts are held together. Of the first but little need be said, as, except for rough goods not requiring to be bleached, as canvass, rick covers, rope-yarn, &c., it could not at present be advantageously used; however, as it costs as much to steep bad straw as good, and the expenses in some such cases exceed the value of the produce, it would appear that the dry or mechanical process may be most beneficially tried when the raw material is of inferior quality,—where there is a difficulty in steeping it properly,—or where coarse fibre only is required. Several modes have, from time to time, been devised for effecting this mechanical separation, of which the following are those most entitled to notice.

In 1812 Lee took out a patent for this purpose, to which Parliament accorded a peculiar privilege, that the time for specification should be extended from 6 months to 7 years. This was shortly taken up by the Irish Linen Board, who expended 6000*l.* in their endeavours to introduce it in the flax districts: one of the machines is still preserved in the White Linen Hall at Belfast. Before the time for specification arrived another patent was taken out by Hill and Bundy, in 1817, and more recently those by Donlan and others have been brought before the public. On the Continent the same attempt has been made, and with like success. Some few years back M. Christian, ancien Directeur du Conservatoire des Arts et Métiers, devised a mechanical process for the separation of the fibre, which appeared to answer well at first, but was afterwards gradually abandoned.

Even in the event of a successful result in the separation, the goods manufactured from the fibre are always liable to be injured by moisture, or any other condition that would act upon the azotized substance, which would still remain enveloping and cementing the fibres together.

The second, the *chemical* or *wet process*, must be considered under three different heads:—the first, when the separation is effected by *simple fermentation*, known as "steeping;" the second, where it is due to the abstraction of the azotized extractive compound, by the agency of *chemical solvents;* the third, where *simply water*, either heated or in the shape of steam, is used. In the

first, a destructive fermentation is carried on at the expense of the extractive matter of the plant, and offensive and noxious gases are generated; in the second this matter is removed by the aid of chemical ingredients, which are costly, and render it of little value; while by the third the whole of the substance abstracted is preserved in a state immediately available, and valuable as a feeding substance. The process of steeping is carried on differently in different districts; the oldest is probably that called "dew-retting," in which the straw is spread out on the grass and carefully watered, so as to supply sufficient moisture to support the action of fermentation in the tissues of the plant. This is a very tedious process, rarely to be met with now in this country, requiring several weeks for completion, and in dry seasons not practicable at all. The usual method is to immerse the straw, either in tanks or pits constructed for the purpose, or in slowly-running streams. Suitable arrangements are made for effecting this:—In Belgium, where it forms a distinct branch of the trade, wooden crates are made, which are filled with the flax, and then carried into the stream and weighted down; in Ireland, and other places where pits or tanks are used, the flax is placed in loose bundles, and kept down by means of planks, or other convenient materials. In a few days a scum appears on the surface of the water, and is succeeded by the evolution of gases in the shape of bubbles, arising from the decomposition now actively at work beneath. Great and constant care is now required that this proceeds not too far, and thus injures the quality of the fibrous portion; it needs constant watching, and removal so soon as the desired effect has been obtained. This is readily seen by the experienced eye, by the manner in which the fibre separates from the shove on breaking a portion of the straw. This process, though less tedious than the dew-retting, still requires a considerable time for its operation—in pools or tanks from 10 to 14 days are required; in streams, where the temperature is lower, from 14 to 21 days are consumed. In both cases much depends upon the quality of the water, and upon the general temperature; any impurities, especially salts of lime and of iron, are very injurious; they retard the fermentation and affect the fibre. These irregularities, both as regards time and effect, produced by the cold steeping, led to the consideration of another method, by which a regulated temperature could be obtained, and the time and risk of the old process avoided. The merit of practically employing heated water for this purpose is due to Schenck, who took out a patent for it in 1846, though the principle was not at all new, and had, indeed, been partially applied for many centuries past.

The first rettery on this principle was established in Mayo,

in 1848; now there are upwards of 20 at work in the different provinces of Ireland, besides several in this country; consuming between 30,000 and 40,000 tons of straw annually. In this the principle of fermentation is the same as in the old process, but is now placed under the control of the operator, who can regulate the action of the steep according to the quantity of the flax, or the article he wishes to produce. An important saving in time is effected; from 72 hours for the fine qualities to 96 hours for the coarse only being required, instead of from 2 to 3 weeks; and a more regular and certain fibre is obtained.

The temperature of the steep is kept between 80° and 90°, and regulated at will by the attendant. Here, however, we have the same destructive fermentation at work as in the ordinary steeping; under a certain control, it is true, but generating the same foul and offensive gases. These gaseous exhalations, which far and near stamp the unpleasant proximity of a rettery, have been examined by various chemists, and have been found to consist chiefly of carbonic acid and hydrogen in nearly equal parts, with combinations of both sulphur and phosphorus with hydrogen. The fermentation appears to be of a peculiar character, merely traces of acetic acid being found, while butyric acid is generated in large quantities. In fact, the fragrant butyric ether, so extensively used as a flavouring substance, especially in the preparation of "pine-apple rum," might readily be collected in considerable quantities from the stinking water of the steeping pools.

At the Belfast Meeting of the British Association last year an interesting paper was read by Professor Allman (Trin. Coll., Dublin), 'On the Development of the Fermentation Fungus in the Fluid of the Warm-Water Flax Steeps;' in which he gave the details of his examinations of the process of steeping by Schenck's patent. The various phases in the development of the minute organism constituting the fermentation fungus were described, and which he found to be analogous with those noticed in the fermenting state of other albuminous liquids. By putting some of them into flax-vats where the fermentation was not commenced it is very much accelerated; and he suggested the question as to whether or not it would be advantageous to apply the principle practically to the process of steeping. In new vats it is always found that the fermentation is not set up so readily as in old ones, which may be accounted for by the fact that some of these cells formed previously adhere to the wood, and thus act at once upon the fluid when placed in the vat. This suggestion of Prof. Allman has been adopted, and found to succeed. Some years ago a method of accelerating the steeping process was in operation on the Continent, where

common *yeast* was employed, the flax being placed in shallow tanks and carefully watered.

In some comparative experiments which were undertaken by the Irish Flax-Improvement Society, in 1850, the following doubts as to the hot-water process were specially investigated, and reported upon:—

1st. That the yield of fibre would be less than by the ordinary method.

2nd. That fibre so prepared would be weakened.

3rd. That the linen made from it would not bleach properly.

In reference to the first objection, the Committee reported that their experiments showed that the uniformity of temperature had the effect of increasing the yield of fibre. In one experiment, conducted at Lisburn by Mr. Davidson, 112 lbs. of flax-straw, after being steeped and dried in the usual way, gave 20 lbs. of scutched fibre; while 112 lbs. steeped by Schenck's process gave 24 lbs. In another 112 lbs. of straw, cold-steeped, gave 14 lbs. 5 oz. dressed fibre; whereas the same quantity of straw yielded, by the hot-water process, 17 lbs. $11\frac{1}{4}$ oz. The increased yield in the first experiment was 20 per cent., and in the second $23\frac{1}{2}$ per cent., in favour of Schenck's process. As respects the second objection the result was equally favourable. In the first experiment, the flax steeped in the ordinary way spun to 96 lea yarn, and that by Schenck's system to 101 lea yarn. In the second, the cold-steeped gave 60 lea, and the hot-steeped 70. The third objection was submitted to an extensive bleaching firm, whose evidence in favour of the hot-water process was very decided. The Committee concluded their report by stating their belief that all reasonable objections had been fairly and satisfactorily met.

Other experiments, on a large scale, confirm their opinion. In ten comparative experiments, made with nine different sorts of flax, it resulted that the average produce of 1200 lbs. of flax-straw gave 144 lbs. of dressed fibre in the hot-steep, and only 118 lbs. when steeped in the old way.

Dr. Hodges, in a paper read at the British Association Meeting, gave a statement, extracted from the returns of the Cregagh rettery (Schenck's patent), of the changes which 100 tons of flax undergo when treated by this process.

100 tons of dried flax-straw yield—

1st. By seeding, 33 tons of seed and husk; leaving of seeded flax 67 tons.

2nd. By steeping, 67 tons of seeded flax, yield of steeped straw 39·5 tons.

3rd. By scutching, 39·5 tons of steeped straw, yield of dressed flax 5·9 tons.
Of tow and pluckings 1·47 tons.

This process is so simple, and the advantages over the old method so manifest, both in respect to time, quantity, and quality of produce, that it is somewhat remarkable that, notwithstanding the knowledge which existed of the value of temperature in respect to fermentation, even in reference to flax itself, it has only quite recently been practically employed. In looking back we find that in 1787 great interest was excited in Ireland by a plan to immerse flax in scalding water—a large portion of the vegetable matter was extracted, and fermentation was more readily set up.

In India, the practice of partially steeping flax and other similar fibres in hot water has existed for many centuries past. According to Dr. Campbell, at Bencoolen the process followed is to steep the hemp in warm water, in which it is allowed to remain for two or three days. In the presidency of Bengal, at Rungpoor and other places, the same practice exists; which appears also to have been followed by the Malays for a long time past.*

An old German process, termed "Molkenrost," in which the flax is steeped in sour whey mixed with warm water, is well known to generate a quicker fermentation, and to produce the finer qualities of fibre. In this the advantages appear to be threefold: the temperature of the mixture is favourable to fermentation, which is assisted materially by the nitrogenized compound (the caseine) of the milk; while the solvent powers of the lactic acid probably aid generally in the disintegration of the straw and the more perfect separation of the fibre. The relation between temperature and fermentation was very clearly shown and described by Hermbstaedt, whose experiments in reference to the chemical principles involved in steeping flax and hemp were conducted at the commencement of the present century.

Many plans have been devised for dissolving out the azotized extractive matter of the straw by means of chemical solvents, both acids and alkalies, and thus doing away with the tedious and noxious process of steeping. Both weak acid or alkaline solutions appear to a certain extent to have this property. These are also rendered more effective by an increase of temperature. Recently, about two years since, the attention of the public was called to a process patented by M. Claussen, in which an alkaline solution was employed for effecting the preparation of flax fibre in a peculiar manner. The attempt itself, however, to cottonize flax

* See Jury Reports, Class 10, p. 96.

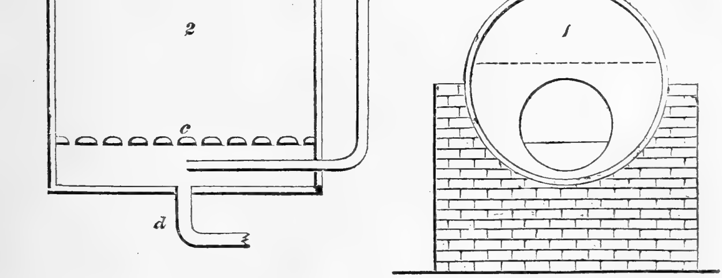
has been discovered to be really no novelty; inasmuch as, in 1775, Lady Moira prepared both flax and hemp fibre in the same manner; the detailed particulars of which are given in the Transactions of the Society of Arts for that year. Specimens of the "flax-cotton," and of the fabrics woven from it, are still preserved in the Museum of that Society, and are remarkable for their beauty and permanence of colour. Previous to Lady Moira's experiments, which were conducted on a considerable scale, and only relinquished because she could not get any one to take the process up and continue the manufacture, the action of alkalies on flax fibre had been described by Lilljikreuses and Palmquist, who, in 1745, had made use of a solution of caustic potassa. In 1777 Baron Meidingen proposed the use of alkaline solutions for the purpose of *cottonizing* flax, and in 1780 a factory was established at Berchtoldsdorf, near Vienna, for carrying this process into practical operation; and similar methods were also brought forward by Kreutzer in 1801, by Stadler and Haupfner in 1811, by Sokou in 1816, and subsequently by several others. At Berchtoldsdorf, not only was the flax fibre made use of for the preparation of "flax-cotton," but a good article was obtained from the tow and refuse fibre. And the same is said to have been done by Haag, near Presburg, in 1788, by Göbelli in 1803, and Segalla in 1811.

From some cause or other, none of these various attempts seem to have been persevered in for any length of time. Either they failed when tested commercially, or the opposition of old-established interests and prejudices seem to have been too powerful for them; for Beckmann, who speaks of its introduction near Brunswick, states that the workpeople determined not to use the new material; though at the same time, he observes, that excellent fustians were made from it, which could not be distinguished from those manufactured from the ordinary cotton. The similarity of this prepared flax to common cotton was remarked by Des Charmes, in 1799, and subsequently the subject received considerable attention from Gay-Lussac, Berthollet, and others, whose investigations included the action of both hot solutions of acid and alkalies separately, and also by alternate immersions. More recently, in 1842, M. Rouchon, of l'Ecole Polytechnique, at Paris, devised a method for preparing flax by means of immersions in a weak acid solution for a short period, and then placing it in a mass kept moist by occasional arrosions. These were repeated daily until the desired effect was produced. The flax was kept tied up in small bundles, and a man and a boy could attend to 2 tons per day. This process is still carried on by Messrs. Bisson and Pradet de St. Charles.

The use of chemical solvents has the advantage of effecting a

great saving of time as compared with either the cold or hot process of steeping, and of being carried on without its unpleasant accompaniments. From 12 to 24 hours are now sufficient, instead of the 3 or 4 days by the hot-water steep, and the 2 to 3 weeks by the ordinary processes. The practice, however, is not likely to gain ground, as the ingredients are expensive, a portion of the products rendered useless, and the fibre liable to be injured unless proper care be taken.

We now come to the third division of the processes due to chemical agency, where simple solvents, as water, either heated or in the shape of steam, is alone made use of. This is a very important advance upon any of the old methods,—the tediousness and irregularity of the steeping process, whether cold or hot, with its noisome accompaniments are avoided,—no expensive chemicals are required,—the chance of injury to the fibre is lessened,—and the whole of the products of the operation are rendered valuable to the manufacturer. This method of treating flax was patented by Watts in the middle of last year, and was shortly afterwards carried into operation on a large scale at Belfast. Its simplicity and effectiveness were speedily recognised; and already several other establishments are in progress in different parts of the country. The whole arrangements required are inexpensive and occupy but little space. The straw is placed in a steam-tight chamber (No. 2), of a suitable size and shape, the top being formed by an iron tank (No. 3) containing cold water, and the lower end having a perforated false bottom (*c*), at about 12 inches from the other. Steam at a low



1. Steam boiler.
2. Steaming chamber.
3. Water-tank (condenser).

a. Steam-pipe.
b. Iron spikes attached to bottom of tank.
c. False bottom to steam chamber.
d. Discharge pipe.

pressure is then blown from the boiler (No. 1), through a pipe (*a*), into the chamber, and, passing up through the straw, comes in contact with the iron top, by which it is condensed; then, trickling down the spikes (*b*) fixed there as points of dispersion, through the mass, it passes through the false bottom, carrying with it the extractive matter thus dissolved out of the straw, and is drawn off by the waste pipe * (*d*). This is continued for from 10 to 12 hours. The straw is then removed, and is passed through four sets of smooth rollers, which squeeze out about 80 per cent. of the water, and at the same time crush the stems, breaking up the central woody core or "shove," and materially assisting its subsequent separation from the fibre. From these rollers it is carried to the drying-house, which is heated by steam-pipes from the boiler, and thence to the scutching frames, where the operation is performed more rapidly and efficiently than when the flax is prepared by the ordinary method, owing to the thoroughly crushed state in which it comes from the rollers. The flax is then ready for market, having passed through the whole process, from the raw material to the prepared fibre, in the short space of about 36 hours.

The importance of this process to the flax interest generally was immediately recognised by the Flax Improvement Society, and a committee of investigation appointed to institute "a careful and extensive series of experiments, with a view to compare it, both in a practical and financial point of view, with the modes of hot and cold steeping generally practised." The Committee made their report on the 3rd of November last. The experiments were personally superintended by the Committee, and flax of ordinary quality operated upon, of which 10 cwt. 1 qr. 21 lbs. was taken and placed in the steaming chamber, when it was submitted to the action of steam for about 11 hours. After steeping, wet rolling, and drying, it weighed 7 cwt. 0 qrs. 11 lbs., and on being scutched the yield was 187 lbs. of fine flax, and of scutching tow 12 lbs. 6½ oz. fine, and 35 lbs. 3 oz. coarse. The yield of fibre in the state of good flax was therefore at the rate of 18 lbs. per cwt. of straw, or 26¼ per cwt. of steeped and dried straw. The time occupied in the process up to scutching was 24¼ hours; the scutching by 4 stands occupied 6 h. 16 m. In this statement, however, owing to some derangement in the drying apparatus, the time required for that is not included; but the committee considered that 36 hours would include the time necessary in a well-organized establishment to convert flax straw into fibre for the spinner. The cost of all these operations in the experiment, leaving out the drying for the reasons stated,

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* See *Note*, p. 206.

appeared to be under 10*l.* per ton of clean fibre for labour, exclusive of general expenses. The valuation of the samples varied from 56*l.* to 70*l.* per ton, according to the quality of the stricks of fibre sent; and the yield on the heckles was considered quite satisfactory. The report throughout was very satisfactory.

Here, then, we have a process which presents the following advantages over the ordinary methods:—

1. Great saving in time.
2. Economy of fibre.
3. Avoidance of any nuisance, and beneficial application of waste products.

Dr. Hodges, to whom the steep liquor was submitted for examination, found that one gallon evaporated to dryness gave—

Of organic matter . . .	353·97	grains.
inorganic „ . .	161·49	„
Total extractive matter .	515·46	„

The organic matter afforded on analysis—

Of nitrogen	17·79	grains.

The inorganic matter possessed the following composition:—

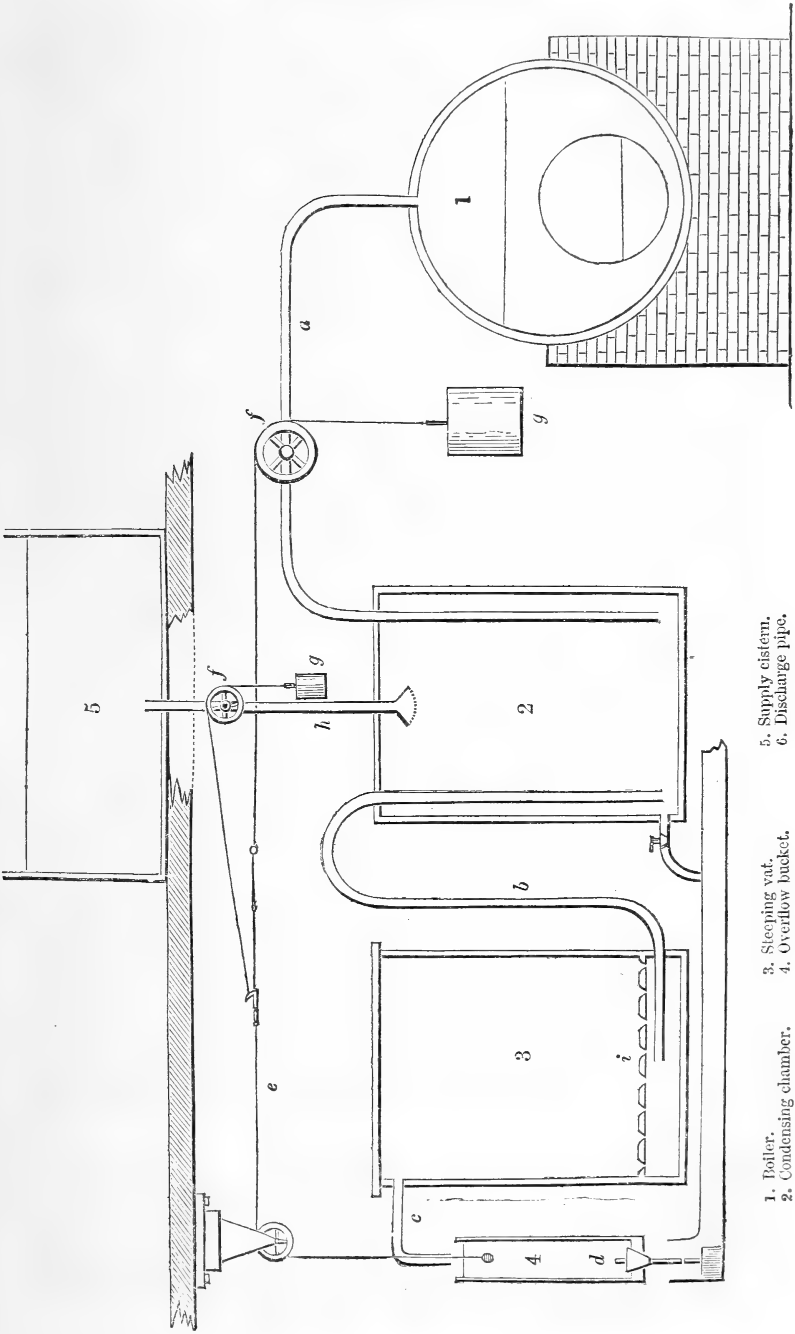
	Per cent.	Per gallon.
Potassa	27·17	44·63
Soda	3·18	5·12
Chloride of Sodium . .	21·58	34·61
Lime	5·91	9.49
Magnesia	4·60	7·40
Peroxide of iron . .	·83	1·33
Sulphuric acid . .	15·64	25·11
Phosphoric acid . .	5·66	9·01
Carbonic acid . .	12·43	19·96
Silica	3·00	4·83
	100·000	161·49

The taste and smell of the liquor very much resembled that of hay, and when poured over the crushed "bolls" or chaff it was readily consumed by cows and pigs, who appeared to thrive on it. No purgative effect had been noticed, while its nutritive properties were estimated as fully equal to distillers' wash.

No sooner, however, had the spinners given their testimony in favour of Watts' fibre, than another process was patented by Buchanan, which appears to be an improved application of the same *principle* as Watts', for the solvent power is clearly not due to the steam as made use of by him, but to the hot water occasioned by its condensation. In this the steeping is effected by *repeated immersions* in a tank of heated water, arrangements being made by which the temperature is never allowed to exceed a certain degree—a point of great importance, both as regards the abstrac-

tion of the azotized extractive matter and also the quality of fibre produced. It is well known that albuminous solutions, containing even a very small proportion of albumen (1 in 1000), coagulate at a temperature of 180°, and then become insoluble; and it is always considered that fibre is more or less injured if exposed beyond a certain high temperature. These two important points have been taken advantage of in Buchanan's process; the temperature of the steep liquor is kept between 150° and 180°, and the operation, both as regards time and produce, more satisfactorily performed. The process is quite *automatic*, thus saving labour and the risks consequent upon carelessness; and the mechanical arrangements by which it is effected are very simple and inexpensive. The flax straw is placed in an open vessel (No. 3) termed the steeping vat, having a false bottom (*i*); a boiler (No. 1) generates the steam required; and between these two is placed a suitable vessel (No. 2), the condenser, of about the same capacity as No. 3, and communicating with that by the hot-water pipe (*b*), and with the boiler by the steam pipe (*a*). This centre vessel or condensing chamber is filled with water from the cistern (No. 5), and steam is then blown in from the boiler. When the latent heat of the steam is absorbed, and condensation no longer takes place, the hot water is driven over into the steeping vat, and completely immerses its contents. The overflow pipe (*c*) then conveys a portion into the bucket (No. 4), which, overpowering the balance weights (*g g*), descends, drawing the chain (*e e*), which, being attached to the pullies (*f f*) fixed on to the cocks of the steam-pipe (*a*), and of the condensing pipe (*h*), reverses their action by cutting off the steam and turning on a charge of cold water into the condenser. The steam in No. 2 is then rapidly condensed, and the liquor drawn back from the steep vat into which it had previously been forced. This completes the operation of immersion, which recommences immediately:—for as soon as the overflow bucket (No. 4) has reached a certain point in its descent it strikes against a pin, having a screw adjustment, which causes the valve (*d*) at the bottom to open and discharge its contents into the discharge pipe (No. 6). The bucket, then relieved of its load, resumes its original position, the balance weights (*g g*) act on the pullies (*f f*), which again reverse the cocks, cutting off the cold water sparge, and turning on the steam to No. 2. This is repeated as often as may be required.

So far as the experiments have gone, it has been found that by ten such immersions the whole of the colouring matter of the flax has been removed. These in practice would not occupy more than three or four hours. This, however, is subject to the test of the operations on a commercial scale which are now in progress in Scotland for carrying out the patent.



1. Boiler.
2. Condensing chamber.
3. Steeping vat.
4. Overflow bucket.
5. Supply cistern.
6. Discharge pipe.

By this process we have all the advantages obtained by Watts—economy of products—increased economy of time, only four hours being required instead of twelve—and, in addition, great economy of labour. Another great improvement is claimed by Buchanan—his method of drying the steeped straw preparatory to scutching. This is usually a tedious and costly process as regards labour and arrangements. The fibre, too, is to a certain extent liable to be injured by the necessary handling. The ordinary mode is to place the flax thinly spread between two wooden laths, which, when closed by means of hooks or rings over their ends, firmly hold the stems: about fifty-six of these are required for a cwt. of flax. They are then carried to the drying shed and suspended from frames, where they remain exposed to the action of the air until they are dry. The time required depends on the weather—from three or four days to as many weeks. In Watts' process, where steam is available, the drying is effected in a heated chamber in a much shorter time. Buchanan's method is entirely different. He proposes to effect the desiccation in the same vat in which the flax was steeped, by means of *dry warm* air, which is driven through it in unlimited quantities, at a very little expense. The air is readily obtained in the desired state by causing it to pass through *porous earthenware* pipes set across the lower part of the chimney. These communicate on the one side with a blower driven by the engine, and on the other side with a pipe which conveys the heated air to the lower part of the vat containing the flax to be dried. This is all the arrangement needed. The blower drives the air through the earthenware pipes; its temperature is there raised, and moisture abstracted, and entering the bottom of the steeping-vat it comes in contact with the flax and passes through it, absorbing and carrying off the moisture, and leaving the flax in a perfectly dry state. It is then ready to be rolled and scutched. The patentee's experiments induce him to believe that by this process the entire operation of converting the straw into dressed fibre may be effected in the working-day, or twelve hours; and, from the simple nature of the mechanical arrangements and of the materials required, a very moderate outlay would suffice for the formation of an establishment equal to the probable produce of a given district. The steeping process being entirely automatic, the cost of labour is very small indeed, and the whole expenses of the operation materially reduced.*

In speaking of the treatment of the flax by these different

* I regret that I am not able to give any results of the working of the process on a commercial scale. I have waited until the last day permitted me, but find the establishment is not yet at work.—J. W. 16th May.

methods I have only referred to it in a dried state, harvested and treated in the usual way. It is not, however, necessary, that it should always be so: it is usually more convenient, it is true, where large quantities are to be operated upon; but where the quantity is small, and can be worked up at once, it would appear from the following comparative experiments that steeping it when green is the most advantageous. M. Dufermont, cultivateur à Hem (department du Nord), found that when the flax was used green the steeping only required from six to seven days; and that six days grassing gave the flax a finer colour than could be obtained by any other means. It was dried and ready for scutching in three weeks; whereas the ordinary time in the district averaged from 1 to 1½ year. He found also that it yielded 5 per cent. more fibre, which was worth fully 10 per cent. more money in the market. The flax was pulled before it was quite ripe, the seed-bolls removed by rippling, and the straw immediately placed in the pits. The seed, however, was reduced about 2 francs per hectolitre in value. The details of the experiments he gives thus:*—

FIRST EXPERIMENT.

—	Value.	Original Weight.	Dried.	Steeped and Dried.	Scutched.	Value per Kilom.	Value of Seed.	Gross Value.
	Francs.	Kilogs.	Kilogs.	Kilogs.	Kilogs.	Francs.	Francs.	Francs.
Green flax.	222	4·030	..	826	191	1·70	27	357·70
Dried ,, .	222	4·030	1·142	178	178	1·55	31	305·90
					Difference . . .			45·80

SECOND EXPERIMENT.

Green flax.	6·05	100	..	26·000	6·350	1·90	..	12·06
Dried ,, .	6·05	100	Grammes. 30·250	22·500	5·500	1·65	..	9·07
					Difference . . .			2·99

The practice of steeping green is carried on to a large extent in the Waes district in Belgium.

Such is a sketch of the different methods of making this substance; their variety, both in principle and practical application, give ample evidence of the value which has always been attached to it in relation to the necessities or comforts of mankind.

* Annales de l'Agric. Française, Mar. 1853.

Flax has ever occupied a prominent position in the agriculture of civilized countries. In our own we have seen that the government of early times encouraged its cultivation by special bounties. This policy was pursued up to a more recent period—nay, it even now is to a certain extent continued.*

Notwithstanding this encouragement the supply has never been equal to the demand, and each year's imports show us the very large sums which we annually contribute to the farmers of other countries for an article of produce especially suited to our own, and which on all hands is now acknowledged to be, under fair management, a paying crop. Our imports of dressed fibre (flax and hemp) average, for the last ten years, 70,000 tons per annum; which, at 40*l.* per ton, amount to 2,800,000*l.* To this we must add 1,500,000*l.*, the value of 650,000 quarters of linseed, used as seed and for crushing purposes; and about 500,000*l.* the cost of 70,000 tons of oilcake, which we annually import, in addition to that made at home, for feeding purposes. The quantity of flax fibre necessary to supply the demand of the United Kingdom would consume the produce of 500,000 acres; while in Ireland during the past year only 136,000 were cultivated, and probably not a fourth of that quantity in the rest of the kingdom. The greatest obstacle that has stood in the way of its cultivation has been the difficulty in finding a market for the straw. Improved farming has readily and beneficially disposed of the seed; and the improved methods of treating the straw, recently brought out, will no doubt tend sooner than anything else to create markets where the grower will find a certain and remunerative sale for it. Let these be once established in suitable districts, and let the relation between the producer and consumer be properly understood—let their respective interests be clearly shown—and I confess I should have far more faith in *their* agency than in any bounty or legislative assistance that could be given.

Having brought my subject through the first period of its technical history, the preparation of the fibre, I may perhaps be permitted to say a few words on the state of the flax industry generally in our own and in other countries, from some of which we draw annually large supplies of fibre. In England, in 1851, the Factory Inspectors' Report gives the number of spindles at 265,568; in Scotland at 303,125; and in Ireland at 500,000: forming a total number of 1,068,693.† In France we find the number of spindles to be about 350,000; the establishments being situated chiefly in the departments du Nord, Calvados,

* 1000*l.* per annum is granted to the Flax Improvement Society, by the Government, in accordance with the Act 11 and 12 Vic., cap. 115.

† The Report for 1852 shows a slight increase.

Finisterre, and Pas de Calais. In Belgium there are about 100,000 spindles in operation; the factories being at Ghent, Liege, Tournai, Malines, and Brussels. Holland possesses only one factory of about 6000, in Friesland. Russia has two large factories, one at Alexandrofsky and the other at Moscow, together numbering about 50,000 spindles. Austria possesses eight factories, with about 30,000 spindles in operation. In the states of the Zollverein about 80,000 are estimated to be in use; and in Switzerland there are three or four small establishments, making between them from 8000 to 10,000 spindles. In the United States twelve small factories exist, having in operation about 15,000 spindles; these are situate in the states of New York, New Jersey, Pensylvania, and Massachussets.

Now, reckoning the average cost of buildings, machinery, and motive power at 90*s.* per spindle throughout, it would appear that there is altogether a *fixed* capital of upwards of 800,000*l.* invested in the trade, of which sum 500,000*l.* belongs to this country. Notwithstanding these large returns of machinery in operation at home and abroad, we find that the hand-spun yarn very far exceeds it in quantity, since throughout the Continent hand-spinning is still carried on to an enormous extent. The consumption of flax worked up by these spindles averages about 25 tons per 1000 spindles per annum for fine yarns, and about 30 to 50 tons for coarse yarns.

Our manufacture of linen has increased from 45,000,000 yards in 1805 to 110,000,000 yards in 1850, notwithstanding the enormous development of the cotton industry during that interval. Our exports, too, testify to the position we occupy in foreign markets. In 1850 these amounted in the aggregate, for yarns, thread, small wares, and woven goods, to 4,828,994*l.*; in 1851 to 5,058,822*l.*; and in 1852 to 5,356,871*l.* Of the woven goods exported, the markets of the New World take the greatest proportion; those sent to the eastern hemisphere being of trifling amount in comparison. From returns recently published we find that 39,000,000 of persons in America consume annually more than 2 yards of our linen per head—equal to 1*s.* $3\frac{5}{8}$*d.* sterling; in Canada the proportion is 1*s.* $6\frac{1}{4}$*d.*, or nearly 20 per cent. more than in the United States; while 228,000,000 in Europe take but 1-38th part of a yard per head. This remarkable difference does not arise so much from the consumption being proportionally less in the countries of the Old World as from the comparatively high duties which most of them maintain on the import of linen goods, and from the small disposition to use them in Asia and Africa, where cotton fabrics are almost exclusively used.

In conclusion, I would merely recapitulate the points which

appear to me most worthy of your attention, and which I have endeavoured to support by the evidence I have been able to lay before you. They are—

Firstly. That the demand for flax produce is greatly in advance of the supply; and that the ratio of difference is annually increasing.

Secondly. That flax is not an exhausting crop: that its peculiar suitability to different soils and climates, the short period it occupies the soil, and the market returns of an average crop, render it a valuable addition to the ordinary rotations.

Thirdly. That the recent improvements in the process of treating flax, whereby the fibre is prepared at an *immense saving both in time and labour*, *all nuisance avoided*, and the *waste products beneficially utilized*, offer great inducements for the establishment of small factories in suitable districts;* thus directly encouraging an increased cultivation by ensuring to the grower a ready and constant market for the produce.

XIV.—*Experiment on Drainage at different Depths.* By R. Milward.

To Mr. Pusey.

Dear Mr. Pusey—I send according to your request the result of an experiment I have made in draining at various depths. The land is strong red clay—the subsoil red or white clay, with some beds of bluestone at intervals, and at various depths. There is no spring water on this farm, and my object in draining it is, that the surface water shall pass off as quickly as possible, to enable me to work the land soon after rain, without injury to it, and that the growing crops may not be perished by the rainwater remaining long in the soil.

Having drained similar land in nearly every year since 1825,

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* The chief impediment to the introduction of the growth of flax in many of the most suitable districts would seem to be the want of a ready market, or of those "small factories" which make it marketable; and the difficulty consists in the question, *Who is to begin?* The farmer does not grow flax for want of the mill, and the mill is not worked because flax is not grown. In some of our woollen manufacturing districts in the west of England, where the larger mills with steam-power have absorbed the trade, there are plenty of the smaller mills with sufficient water-power untenanted—mills which in former times were let at 100*l.*, 200*l.*, 300*l.*, and even 400*l.* a-year, and which might be taken at a rent certainly under 50*l.* In such districts, at least, the inducements held out in the text should have their weight; and it might be worth the consideration of those interested in the question whether, by some combined arrangement to plant a certain number of acres for a few years with flax, they might not succeed in inducing intelligent and enterprising foremen to convert some of these old woollen into flax-dressing mills.—W. H. Hyett.

my opinion was decidedly in favour of 30 inches depth, but I wished others to be convinced, and accordingly I stated in November, 1849, to the Agricultural Society of this county (Notts), that I would have a field drained at three different depths. This was done in February, 1850; the field is 8 acres, and contains 15 furrows, so that there were 5 for 2 feet; 5 for $2\frac{1}{2}$ feet; 5 for 4 feet. The lands are all of the same width, between 6 and 7 yards. The field was sown with barley in 1851; seeds pastured in 1852; and the same this year. There has been no perceptible difference in the crops or appearance, and after rain, contrary to the received opinion, the shallow drains begin to run before the others. The field, or in fact the whole of my farm, is open for the inspection of any person, and if I should be from home my bailiff will give every information on the subject.

I intend the field to be sown with oats in 1854, and I hope you will see the crop growing in July, as the Station here is only 24 miles from Lincoln.

Believe me yours very truly,

RICHARD MILWARD.

Thurgarton Priory, Southwell, June 2, 1853.

XV.—*On the Comparative Profit realized with different breeds of Sheep.* By SAMUEL DRUCE.

To Mr. Pusey.

DEAR SIR,—The subjoined table was compiled in reply to a letter from the American minister at Paris, after visiting England on an agricultural tour, when some of the principal flocks were inspected by him, but he had not an opportunity of seeing mine. I was therefore prevented from a personal interview, and consequently conveyed in this form my ideas as to the relative value of the English breeds of sheep, and I have much pleasure in sending it to you at your request.

This subject seems to take the attention and call forth the energies of the farmers in consequence of the advance in the price of wool and mutton. The prices named in the table for Cotswold and shorter wools are nearer on a par this season than they have been for years, in consequence of the great demand there appears to be for coarse fabrics for exportation. In a general way Cotswold wool is from 10 to 15 per cent. lower than cross-bred.

Description of Sheep.	Comparative numbers that may be kept.	Average weight of Ewe Fleece.	Average weight of Teg Fleece.	Present Market Value of Ewe Fleece.	Present Market Value of Teg Fleece.	Carcase weight of Tegs when fat at from 13 to 15 months old.	Present Value in Smithfield Market.
		lbs.	lbs.	per lb.	per lb.	st. lbs.	per 8 lbs.
Cotswold . . .	100	5 to 7	7 to 10	$15\frac{1}{2}$*d.*	16*d.*	10 or 80	3*s.* 10*d.*
Leicesters . .	105	4 to 6	5 to 8	$15\frac{1}{2}$*d.*	$16\frac{3}{4}$*d.*	$8\frac{1}{2}$ or 68	3*s.* 10*d.*
Hampshire Down	115	3 to 5	5 to 7	$15\frac{1}{2}$*d.*	18*d.*	$8\frac{1}{2}$ or 68	4*s.* 4*d.*
Pure South Downs	120	2 to 4	3 to 6	$16\frac{1}{2}$*d.*	$18\frac{1}{2}$*d.*	$7\frac{1}{2}$ or 60	4*s.* 6*d.*
Cross-bred . .	115	4 to 6	5 to 8	$16\frac{1}{2}$*d.*	18*d.*	$9\frac{1}{2}$ or 76	4*s.* 4*d.*

It is nearly twenty years since I began crossing between the Southdown and Cotswold sheep, and with the ordinary skill of sheep-farming I find no difficulty to keep the form and size of the animal as it should be, the wool of a valuable quality and not deficient in quantity; and I maintain that the good qualities can be better secured by employing the cross-bred animals on both sides than by using the first cross. I know of other farmers who can affirm what I now assert.

It is a well-known fact that the layer and situation are of great importance to a flock, and the land I farm, which is of variety of soils, from the strong clay to the burning gravel, seems particularly adapted to this improved cross-breed sort.

It may be well to state the different kinds of food that are grown on the "variety of soils," in order to keep them on the arable land.

In January, swedes or turnips.
February, the same.
March, the same, and mangold.
April, mangold, rye, and vetches.
May, trefolium, vetches, and trefoil.
June, vetches and clover.
In July, summer vetches and clover.
August, rape and vetches.
September, rape and early turnips.
October, early turnips.
November, turnips.
December, turnips and swedes.

The ewes generally run over the pastures from November to January, when they are brought to the yard for lambing; they are fed on the best hay and roots, and sent in the ploughed fields as soon as the lambs get strong.

I remain, dear Sir,
Yours faithfully,

SAMUEL DRUCE.

Eynsham, May 25th, 1853.

(Note by Mr. Pusey.)

I cannot but think that this statement, from so high a practical authority as Mr. Druce, will forcibly attract the attention of flockmasters. According to his estimate, founded chiefly on experience, the results in money, supposing the lambs to be sold as mutton at the year's end, would be as follows:—

	Fleece.		Carcase.		Single Teg.		Entire Flock.		
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*£.*	*s.*	*d.*
Cotswolds	11	4	38	4	49	8	248	6	8
Leicesters	9	10	32	7	42	5	222	12	9
Pure South Downs . .	6	11¼	33	9	40	8¼	204	2	6
Hampshire Downs. . .	9	0	36	10	45	10	263	10	10
Cross-bred	9	11¼	41	2	51	1¼	292	18	0

The difference in favour of the cross-breds is certainly very great; it arises, of course, from the superior quality, and therefore higher price *per pound*, of the mutton as compared with long-woolled sheep, and the superior weight of wool and of mutton as compared with short-woolled sheep. Mr. Druce would be the last man to say that his own experience should decide farmers who keep flocks on a different kind of land, where the figures doubtless might come out very differently, or to recommend the abandonment of any of our improved breeds—Leicester or Cotswold long-wools, Sussex or Hampshire short-wools. The question is, not whether we should give up any of these, but whether we do not require, in addition, a fifth or *middle-wool* breed beside them. I believe that we do, for half-bred sheep of the first cross are yearly brought more and more to market. But the evident disadvantage of the system of using only a first cross is this, that as you do not breed your own ewes, you must purchase some every year; while, as farmers never sell the best of their young ewes, those who thus depend upon purchase cannot keep up a superior breeding flock. The difficulty of establishing a new breed, as is well known, consists in the tendency of the cross for many generations to revert to one or other of the original races. Still, many farmers have now for some years bred this sheep, intermediate between the long-wool and the down, and have thereby laid a foundation on which, if it be thought fit, others may build. Some light, too, I hope has been thrown on this interesting subject by a French breeder, whose experience forms the subject of the following paper—Ph. P.

XVI.—*On a Method of obtaining immediate Fixity of Type in forming a new breed of Sheep.* By M. Malingié-Nouel, Director of the Agricultural School of La Charmoise, President of the Agricultural Society of Loire et Cher. Translated by Mr. Pusey.

It would certainly have been very convenient for French farmers if we could have appropriated the results of the long labours of the English, who have succeeded, as all the world knows, in creating races of sheep the best suited to modern requirements. If the thing had been possible for us, it ought to have been effected without national jealousy, but, unluckily, it was not possible. The chief races of English sheep, formed under certain circumstances, cannot remain what they are, where those circumstances are altered. In all countries south of Great Britain there is great difficulty in fulfilling this condition, and even then the expense is such as to swallow the profit. Merinos have been transferred from Spain to the north, even as far as Norway and Sweden, but English sheep do not thrive when carried southwards to a country even so near as France. It seems, therefore, almost certain that sheep cannot be moved so easily from north to south as from south to north.

But though the races of English sheep could not be kept up in France, we yet might fairly entertain the hope of crossing them with our native breeds. Here then a wide field opened itself for experiments neither expensive nor, as might have been supposed, even difficult. Accordingly there arose a host of experimenters, most of whom, unacquainted with the first principles that govern reproduction, proceeded headlong in the blind hope that chance would afford them that happy solution which they were unable to ask of science, and which chance after all did not give them.

Now, it certainly would be in our power, without quitting French breeds, to form a race of our own, perfect in form, and possessing, like the English breeds, early maturity, with aptitude to fatten. For this purpose we might pursue a course of judicious selection for a long series of years, aiding this selection by a system of constant care and of nutritious food. But besides that such long-winded operations, requiring great perseverance of view and of will, seldom find men determined enough to conceive and, above all, to execute them, they require in fact more than the ordinary life of man, and therefore cannot be carried out without a succession of experimenters animated by the same views, and employing similar means. Such an enterprise cannot be executed unless by a man who, like the founder of the New Kent breed, Richard Goord, commences young, and lives like him eighty-six years.

In France such an improvement of a breed in itself or *from within* has not been even attempted, at least with respect to perfection of form, power of assimilation (or fattening), and quality of meat. As to the wool, indeed, our breeders of Merinos, while their wool was dear, did aim at increased fineness and evenness of fleece by judicious selection, and in some degree too succeeded. But their success is of little interest now that the price of superfine wool has been lowered permanently by the multiplication of Merinos without cost on the untenanted pastures of Australasia.

The most devoted partisans of the Merino breed have now for some time felt the necessity for making up in mutton what they were losing in the price of their wool. This they could hardly effect with that boniest of all races unless by alloying in some degree the purity of its blood. At first this degradation was concealed, but, gradually growing bolder, they pronounced at last the word "cross." Still it was required that the new animal should preserve the Merino countenance, and that its wool, though coarser, should be fit for the same purposes as before. This latter object was much favoured by a natural law, as well as by the progress of manufactures. In fact, through the improvement of machinery new stuffs are now produced from the coarse wool as delicate as heretofore from the fine.

Hence arose a multiplicity of spurious sheep, denominated justly *mongrels*, yielding a wool of little value, that could not be compared with the cleaner and stouter wools of Australasia. The two kinds of fleeces show, in fact, the different treatment by which they are produced. Life in the free air and constant pasture, upon the one hand; on the other, the precarious food, the filth and stench of close yards, to which most of our French flocks are to this day exposed. The depreciation of the wool of the *mongrels* cannot stop even at its present point, for the product of Australasia must go on increasing under the continuance of peace, and the progress of marine intercourse, which tends to draw closer the communion of nations—as close as that of provinces in the middle ages. But if the wool of our *mongrels* bears small promise of future profit, those sheep have certainly little to recommend them in point of mutton, which retains the taint of their origin.

This disfigured foreign race, then, is in the same case with the old native races of our ancient France that have withstood better than she herself has done the endless revolutions of which she has been the sport. These breeds satisfied the simple requirements of our ancestors, but in our days you might as well try to restore the coarse clothes worn by those ancestors and the frugal life which they led, as propose to satisfy the demands of our manufacturers and the wants of our increased population from breeds with coarse wool and unthrifty frame, subsisting miserably

on the spontaneous produce of soils either naturally barren or ill-cultivated.

Many causes thus naturally led our farmers to crossing with English breeds: first, the deplorable state of our old French breeds as to both mutton and wool; next, the imperfection as butcher's animals of the Merino *mongrels* which have replaced the old breeds wherever the goodness of the soil and excellence of the forage allowed their introduction. Besides, a certain amount of enlightenment had evidently penetrated the minds of our farmers, which we must hope will lead to improvement in the feeding and management of French sheep. For hitherto these valuable animals have been, and still are on most of our farms, treated as mere outcasts. They are crowded together without light or air in hovels which are rendered unwholesome by the fermentation of the droppings accumulated under their inmates perhaps for a year. In summer they receive only the natural produce of the soil; in winter, straw, and that straw often damaged. Even this fodder often does not hold out, and then the flocks have no other resource than to gnaw the heath and shrubs with which the commons are covered, or scratch in the snow to find some blades of withered grass. On this sad but true picture a ray of light has at last been shed. In many places our farmers begin to perceive the need of improved management, and, wherever improvement begins in the management, it is soon found to be also required in the breed. The only merit of the old breeds is that they are not destroyed by such management, but they will not pay for more generous diet.

For it is a mistake to improve the flock without changing the management. It is an equal mistake to improve the management without refining the breed. Both should advance together if profit be looked for.

Still it has been found that our old breeds may be crossed with English blood not only without profit, but with heavy loss. To clear up this matter, it will be worth while to enter into particulars, as the question is interesting, and in general not well understood.

When an English ram of whatever breed is put to a French ewe, in which term I include the *mongrel* Merinos, the lambs present the following results. Most of them resemble the mother more than the father; some show no trace of the father; a very few represent equally the features of both. Encouraged by the beauty of these last, one preserves carefully the ewe lambs among them, and, when they are old enough, puts them to an English ram. The products of the second cross, having 75 per cent. of English blood, are generally more like the father than the mother, resembling him in shape and features. The fleece also has an English character. The lambs thrive, wear a beautiful appearance, and complete the joy of the breeder. He thinks that he

has achieved a new cross-breed insuring great improvement, and requiring thenceforth only careful selection to perpetuate by propagation among themselves the qualities which he has in view. But he has reckoned without his host. For no sooner are the lambs weaned, than their strength, their vigour, and their beauty begin to decay as the heat of our summer increases. Instead of growing, they seem to dwindle; their square shapes shrink; they become stunted, and, on the threshold of life, put on the livery of old age. A violent cold in the head completes their exhaustion. This is accompanied with a copious flow of slimy mucus from the nostrils, constant sneezings, and sometimes cough. At last the constitution gives way, or, if the animal last till autumn, the malady indeed ceases but he remains stunted for life. The time lost was the time of growth, and cannot be recovered, for nature never goes backward. Henceforth he looks like a foreigner escaped from the mortal influence of an inhospitable climate, and remains inferior even to our native sheep, which at least have health and hardiness in their favour.

The experiment has sometimes been tried with English rams in a third generation, and the symptoms above described have arisen even more strongly in proportion to the stronger admixture of English blood. Thus experience has shown us that English sheep of whatever breed, being formed under the peculiar circumstances of Great Britain, require absolutely the continuance of those circumstances to remain what they are. These circumstances, again, we have found, cannot be realised in France without infinite precautions, and an expenditure that destroys the most indispensable of all requisites in such operations, namely, profit.

It is, moreover, remarkable that the results described arise equally with each kind of English ram that has been used, namely Leicester, New Kent, and Southdown. Only the foreign influence is more marked in the product of Goord's New Kent or of the pure Southdown than in that of the Leicester or the less pure New Kents or Downs; in fact the principle of antiquity or purity of race is what has most influence upon crosses.* The Leicester and other rams of mixed origin being of very modern origin in comparison with our French breeds, and especially with the Merinos, whose source is lost in the night of ages, their influence must be, and is in fact, weaker than that of the mother. This difference of action, which should be clearly understood, establishes shades of distinction distinctly marked according to the kinds of ram that are used.

Thus, if you put a Leicester ram, a mixed New Kent, or a

* Consult on this subject the excellent work of Mons. Hurard, *Des Haras Domestiques.*

Southdown, that is not pure to a pure ewe of any French race, very little English character is impressed on the offspring, never less than when the ewe is a pure merino. In this last case it often happens that you can see no difference between lambs that are Leicester merinos, Kent merinos, or Southdown merinos, and another lamb of the same age which is pure merino. In compensation, however, for this feeble influence of the English sire, the lambs of such first crosses have no more difficulty than French lambs in getting over the first summer.

If on the contrary the same ewes are put to very pure rams of the Southdown or New Kent breed, the English character is more marked than in the former cases. These facts agree with the principles we have just referred to.

In both cases the offspring is reared; for lambs in which the English blood does not exceed one-half seem to be reared as easily as pure French lambs. But then, since little improvement is obtained, one is tempted to give a new dose of English blood—to put the Anglo-French ewes to English rams—whereupon the disasters described are sure to follow. These are truths which should be generally known, for they are purchased at a great cost of time and money. In fact, if one wishes to procure a breed of sheep such as is now wanted, good for the butcher, of early maturity, with power of laying on fat, above all hardy and economical, one is daunted by the length of time required for such an operation, if it is to be effected by gradually improving one of our native races through selection, food, and management. One turns from such an undertaking to what seems the easier road of crossing. For this purpose one looks naturally to the English breed because they alone in the world possess the qualities sought for. We cross therefore our French ewes, suppose, with the English race earliest known in France, the Leicesters, and obtain lambs showing little improvement. Disappointed we turn to a fresh breed, the New Kents, of recognised excellence. We obtain a degree of improvement more perceptible yet insufficient. Discouraged by these trials in which years have been wasted, tempted almost to despair, one hears of another breed, the Southdowns, as a race hardier and smaller than the other two and therefore apparently better suited to French farming. One makes this last effort, which answers worse than the others; for if the Southdown rams exert an influence in the cross as strong as that of the New Kents, and rather stronger than that of the Leicesters, the effects are less advantageous inasmuch as these rams are inferior in shape and in wool.

I must here remark, that in France we are in error respecting the Southdown breed. These animals are smaller than the Leicesters and New Kents, and therefore more easily satisfied. They are at home upon short pastures, and thrive where other

breeds would perish. This quality seems invaluable to the French farmer, who is accustomed to cultivate no crop (either grasses or roots) for his sheep, and hopes to find an animal that will live and even fatten on nothing. An animal therefore which, as he hears, lives in England on the bare and parched heights of the downs, seems to him much likelier for his purpose than those balls of fat and of wool which roll lazily as they fatten in the rich valleys of Kent or Leicestershire. He would be right if any pure English race could thrive in France, but of this experience has shown the impossibility.

This fact being established, we can consider English breeds only with a view to crossing. Now as in crossing one gains but in part the good qualities of the sire, we require, if the improvement be sought from the sire, that he be of the most perfect type, that so his influence may be greater, but his influence will be the less both on shape and on wool in proportion as in those points he comes nearer to the mother who is the base of the operation. By employing, therefore, Southdown sires which are relatively inferior in those points, we obtain less improvement than by blending with either of the other two English breeds, while the difficulty remains the same in rearing the lambs if we go beyond the first cross. Still it may be said, you have not exhausted the subject by your many and various trials with the three English breeds of which you have spoken. The further question arises in looking for the new animal we require, namely whether some French breeds be not better suited for the purpose than others, whether the ill-success of your experiments have not arisen from imperfect mothers rather than from sires known to be perfect. But these trials have in fact been made with different French breeds, yet with uniform disappointment.

While one is varying these experiments with rams of various English breeds and ewes of various French breeds, years roll on and time slips away. No one of course can expect to solve such a question in the space of one life without making many such trials at once. Hence arises a complication of care and of facts to be registered with exactness, if one hopes to reach the light through so many dark and narrow passages. It is on this difficult ground that the writer has laboured for many a long year, acting on opinions the most erroneous, led by the most varying opinions, subject to mortifying mistakes, often losing almost every ray of hope, and on the point of giving up all result from so much anxiety, so many journeys, and so much expense. But it often happens that the human mind harasses itself long in search of a thing which might have been found easily by acting scrupulously upon laws of nature that were already known, instead of groping in the dark among accidental circumstances.

Now, in all breeding, experimenters attach the greatest im-

portance to purity of race on each side, because of the natural law by which the offspring resemble, not merely the father and mother, but sometimes the grand parents, great grand parents, and further back still. Many other observers as well as myself have seen in young animals the clearest resemblance to some ancestor long since dead who was marked by some distinctive feature. The purer the race of such ancestor, the more strongly do its characteristics overcome the subsequent mixture of breeds and imprint themselves on the new offspring: would it not then have been more reasonable for French farmers to attach the utmost importance to purity and antiquity of blood in the ram, representing as he does the improved type that is aimed at, but to avoid on the other hand those qualities in the ewe whose defects were to be corrected? In giving motion to a projectile (for instance a cannon-ball) the velocity obtained is not merely in proportion to the propelling force, but also to the resistance of the medium (air or water for example) through which the body is driven. Now in our case the ram represents the power of propulsion, the ewe that of resistance: since, if there were no obstacle on her side, the complete effect would be realized by the faithful reproduction of the improving type. Clearly, therefore, the influence of the ram upon the offspring will be the stronger the purer and more ancient in the first place his own race may be; and in the next place, the less resistance is offered by the ewe through the possession of those qualities of purity and long descent which are so valuable in the sire. We have seen above, and it is true of every attempt at crossing in France, that an opposite state of things had obtained in all these trials; since purity and antiquity of blood exist much more strongly in the French breeds than in the English, which have been much more recently formed. The imperfect result then of all these attempts is perfectly accounted for by our reversal of a great law of nature; and it seemed to me necessary to restore this law and give the advantage of it to the English ram. Such was the preliminary condition of success.

It appeared then that in order to untie the Gordian knot whose threads I have traced, inasmuch as one could not increase the purity and antiquity of the blood of the rams (I purposely repeat the first principles of the problem to be solved), one must diminish the resisting power, namely the purity and antiquity of the ewes. With a view to this new experiment, one must procure English rams of the purest and most ancient race, and unite with them French ewes of modern breeds, or rather of mixed blood forming no distinct breed at all. It is easier than one might have supposed to combine these conditions. On the one hand, I selected some of the finest rams of the New Kent breed, regenerated by Goord. On the other hand, we find in France many border countries lying between distinct breeds, in which

districts it is easy to find flocks participating in the two neighbouring races. Thus, on the borders of Berry and La Sologne one meets with flocks originally sprung from a mixture of the two distinct races that are established in those two provinces. Among these then I chose such animals as seemed least defective, approaching, in fact, the nearest to, or rather departing the least from, the form which I wished ultimately to produce. These I united with animals of another mixed breed, picking out the best I could find on the borders of La Beauce and Touraine, which blended, the Tourangelle and native Merino blood of those other two districts. From this mixture was obtained an offspring combining the four races of Berry, Sologne, Touraine, and Merino, without decided character, without fixity, with little intrinsic merit certainly, but possessing the advantage of being used to our climate and management, and bringing to bear on the new breed to be formed, an influence almost annihilated by the multiplicity of its component elements.

Now, what happens when one puts such mixed-blood ewes to a pure New-Kent ram? One obtains a lamb containing fifty hundredths of the purest and most ancient English blood, with twelve and a half hundredths of four different French races, which are individually lost in the preponderance of English blood, and disappear almost entirely, leaving the improving type in the ascendant. The influence, in fact, of this type was so decided and so predominant, that all the lambs produced strikingly resembled each other, and even Englishmen took them for animals of their own country. But, what was still more decisive, when these young ewes and rams were put together, they produced lambs closely resembling themselves, without any marked return to the features of the old French races from which the grandmother ewes were derived. Some slight traces only might perhaps be detected here and there by an experienced eye. Even these, however, soon disappeared, such animals as showed them being carefully weeded out of the breeding flock. This may certainly be called "*fixing a breed*," when it becomes every year more capable of reproducing itself with uniform and marked features. Such was my secret, which, however, has been made no secret at all, but has been declared from the first in my entries at the shows of Poissy and Versailles. Such is the origin of the La Charmoise breed of sheep.

We have already seen how important it is that you should not infuse into a new breed more than fifty per cent. of English blood, if you would preserve the French constitution, which alone suits the circumstances in which they have to pass their lives. The Charmoise breed not exceeding that proportion does retain the hardiness of a pure French race: the lambs are reared as easily as those of any French breed, getting over the summer just as

easily: neither then nor later do they suffer more than our native breeds from heat or from drought.

The mixed-blood mothers had been formed from breeds in general small, and possessing the usual qualities of small breeds, delicacy of shape, smallness of the head and the bony structure, temperance as to food. The Merinos alone had not these valuable qualities, but they entered in the proportion of 25 per cent. only into the mothers, and consequently of 12½ per cent. only into the offspring. Their disadvantage, too, in these respects was compensated by their influence on the fleece.

I may here remark that, in founding a breed, it is far better to choose ewes from small breeds, with the qualities already mentioned, than from breeds that are strongly timbered, bony, coarse, greedy, like those of northern and western France, which I tried myself, to my own heavy loss. Accordingly as fine or coarse ewes are used, so in proportion do the offspring show that coarse or fine character, difficult to describe for a writer, but easy to perceive for a connoisseur.

Besides, it is an admitted fact, that a sheep affording 112 lbs. of meat is more expensive to feed than two sheep, each of 56 lbs. Luckily, on this head the interest of our butchers, the taste of our consumers, and the profit of our farmers are all in unison. The weight generally preferred in France for sheep is 56 lbs. At this point it is easy to stop the Charmoise breed. I say stop them, because weight is one of the things which man can most readily increase or diminish in any breed; in fact, as the size of the being to be fashioned depends upon the ram, it will be reproduced similar to the sire, if no obstinate resistance of another fixed breed be opposed to it. It will then develop itself more or less in proportion to the food received by the lamb. It is not difficult, by increase of food, to double, or even more than double, the result. By feeding differently lambs born from similar parents, we have brought some to the dead weight of 75 lbs. at 14 months, while others gave only 30 lbs. of meat at the same age. The weight of 56 lbs. may be taken as the mean between these two extremes.

In putting my small mixed-blood ewes, that weighed alive not above 56 lbs., to heavy New-Kent rams which weighed often 225 lbs., one apprehension alarmed me—the fear, I mean, of losing ewes which had cost so much trouble, when the time came for their giving birth to the large offspring one naturally expected. But no such danger arose; and the reason seems to me clear. Whatever be the size of the ram, the germ develops itself only in proportion to the nourishment it receives. Now, while it remains in the womb of the small ewe it obtains but little support; consequently the lambs remained small, and the births took place without difficulty. In 2000 labours we had but one death that was

occasioned by the immoderate size of the lamb. It was curious to see such small offspring engendered by such huge sires. But these little creatures, if well fed, soon began to grow rapidly, and it was not uncommon to see ewes sucked by lambs larger than themselves.

From the first dropping of our lambs, the strongly-marked English character gave us the strongest hope that they would retain the excellences of the English fathers; and this hope was not disappointed. The young animals as they grew up preserved their beauty of form, maintained their condition without extraordinary food, and did not suffer from weaning. The ewe-lambs were carefully preserved, a few ram-lambs selected, and the rest castrated. The good condition of these tegs at the end of the first autumn induced us to fatten them. These young things fattened just like old sheep of French breeds, and at the end of winter yielded 56 to 65 lbs. of meat, with 11 to 13 lbs. of tallow.

The next year the same cross was tried with the same success.

The third year was still more interesting. Our first ewe-lambs, at the age of 20 months, had been put to the rams which had been saved. The offspring was most equal in quality, though proceeding from parents which were a first cross; indeed they were more level in appearance than the offspring of some native flocks.

From that time now for some years there has been at La Charmoise a double set of lambs; one set from the New Kent rams and the mixed-blood ewes, another from rams and ewes the result of that cross.

A remarkable circumstance continues to this very year—I mean the perfect resemblance of the two sets of lambs obtained by the two different methods. I have often divided them into lots, and then found it impossible, even by careful examination, to distinguish one set of lambs from the other. This fact is most important—it proves that the breed is established. It only remains, in order to attain the utmost fixity and perfection, that we select carefully the rams and the breeding ewes. This is what will be henceforth done. At first we kept all the ewe-lambs, in order to reach the amount of 500 breeding ewes, the limit of our establishment. We have now the power of selection, in order to keep up that number; and we have great encouragement, in the prizes* already won, still further to improve this breed by careful selection.

Note.—It was in the first number of this Journal the late Lord Spencer stated, he had observed that the worse bred the female is, the more likely is the offspring to resemble a well-

* It is stated that the La Charmoise breed have taken prizes whenever they have been shown at Versailles or Poissy.

bred sire; and he told me that, practically, he should prefer a cow of no breed, to an indifferent pure-bred cow, for a good thorough-bred bull. The principle, however, has never been so thoroughly carried out as in the above experiments at La Charmoise, for the communication of which I am indebted to Mr. Rives, the late diplomatic representative at Paris of the United States. Besides their practical value, I cannot but think they throw some little light on one of the most mysterious of all physiological problems—the renewal of the features of parents in the reproduction of animals.

PH. PUSEY.

XVII.—*On the Subsequent Manuring Effects of Burned Clay.* By J. J. MECHI.

To Mr. Pusey.

DEAR SIR—On the 10th of October, 1846, I made a communication to our Society on the subject of burned clay (vol. vii. p. 299). I therein stated that I had burned 400 cubic yards per acre on a poor plastic yellow clay, that 250 loads or yards per acre had been removed to other fields, and that the remaining 150 yards per acre were spread where burned. The field is opposite my residence, and, years having elapsed, it may be interesting to deduce the results after so long a period. The field, before burning, was a poor 2-years ryegrass lea, and my neighbours seriously predicted that by removing 250 yards per acre of the top soil I should ruin the field. Fortunately, anticipating such objection, and desirous to arrive at comparative results, I left about half an acre of the field undisturbed. It has been, since, all equally treated, viz. oats sown down with grass-seeds, and is still in grass: so far from the burning and removal of so much soil being injurious, in every crop and to this very day the worst portion of the field is that which was unburned and unpillaged. The fact is interesting and encouraging to earth-burners of strong clays. In every case in which I have used burned earth (I mean poor cold argillaceous subsoil clay, free from organic matter), I have during the last 7 years had reason to be satisfied with its advantages, which are still obvious.

I am, dear Sir, yours truly,

J. J. MECHI.

Tiptree Hall, Kelvedon, Essex,
May 30, 1853.

XVIII.—*On the Silica Strata of the Lower Chalk.*

By J. Thomas Way and J. M. Paine.

The readers of this Journal will remember that in the Second Part of the Twelfth Volume we published a paper on the Chemical Composition of the Strata of the Chalk Formation—and that we there gave a chemical and geological, as well as an agricultural, description of the different distinctive beds from the gault clay in an ascending series through the upper green sand and the chalk marls to the upper chalk.

The chemical investigation of these strata was undertaken from the conviction which we entertained that a knowledge of the composition of the various beds which in many cases come to the surface and form the staple soil of large tracts of country, and in others are but slightly covered with transported materials, would be of the greatest possible advantage to the agriculture of all those districts which are situated on the chalk formation: and indeed we believe that the extension of this method to the examination of other geological formations would be most desirable.

One of the beds or strata in the series referred to was described under the name of "soft brown rock" above the gault; and as it is of this bed and of those of the same kind that we have now to speak, we shall make no apology for repeating the analysis here. In page 549 of the above-mentioned paper we find the description and analysis of the rock as follows:—

"Immediately above the gault, with the upper member of which it insensibly intermingles, lies this soft white-brown rock, having the appearance of a rich limestone. It is very remarkable on account of its low specific gravity, and still more so considering its position by reason of the very small quantity of carbonate of lime which it contains. There are numerous small fissures in the rock, which constitute a natural drainage. It is one of the richest subsoils of the whole chalk series, being admirably adapted for the growth of hops, wheat, beans, &c., and indeed nearly the whole of the out-cropping of this subsoil from Farnham to Petersfield is under cultivation for the first-named crop. When exposed to frost the rock crumbles into a fine powder. In the neighbourhood of Farnham, during the last ten years, many thousands of tons have been dug and used as a manure, under the impression that it was a 'good marl.' This is so far mistaken as regards the meaning of the word marl, which, correctly speaking, should only be applied to a substance containing much carbonate of lime. All those persons who have employed it concur in expressing a favourable opinion of its effects; and particularly on some sandy soils the benefit derived from its application is most striking. That we are not to attribute this effect to the presence of lime in any form is evident from the composition of the substance as given below.

"At the present time it is still extensively quarried for manure. This section of rock at Farnham is about 40 feet in thickness, and as it approaches the next stratum above it gradually assumes a harder character, and does not so readily moulder into soil by exposure.

"Analysis of soft brown rock immediately above the gault:—

	Per cent.
Combined water and a little organic matter	4·15
Soluble in dilute acids, 57·10:—	
Silicic acid (silica)	46·28
Carbonic acid	none
Sulphuric acid	trace
Phosphoric acid	ditto
Chlorine	none
Lime	0·26
Magnesia	·07
Potash	·79
Soda	·43
Protoxide and Peroxide of iron	6·12
Alumina	3·15
Insoluble in acids, 38·75:—	
Lime	2·91
Magnesia	traces
Potash	1·51
Soda	·60
Alumina, with a little oxide of iron	14·20
Silicic acid and sand	19·53
	100·00

And at the end of the paper it is remarked that a further careful study of this rock may throw light on the composition of soils.

We were not unaware at that time of what we have since learnt more fully, that this particular stratum of earth contained a large proportion of silica in that peculiar form or condition which is known to chemists under the name of soluble silica; but we were unwilling to mention this circumstance until, by careful investigation, we had assured ourselves that the substance in question existed in quantity and under conditions that would render it available for any agricultural use to which its peculiar properties might adapt it: in fact, we desired to ascertain, before inviting attention to the subject, that this soluble silica rock might serve some more useful purpose than to be placed as a curiosity in the cabinet of a geological collector. Since the publication of that report upwards of one hundred specimens of the earth have been collected at different depths and from different spots where the stratum is found (in the neighbourhood of Farnham), and have been transmitted to London for analysis; and it is the object of the present paper to record these examinations, and to describe the stratum generally, as well as to point out, so far as they have occurred to us, the uses to which this source of soluble silica may eventually be applied in the interests of agriculture.

But, before we proceed further, it will be necessary to explain what is meant by soluble silica. The most common forms of silica known to the farmer are those of sand, flint, and pebbles, and as such, silica constitutes a very considerable portion of the crust of the globe; but by far the largest quantities of this

element within our observation exist in the combined or compound form—that is to say, as silicates of alumina, iron, potash, soda, lime, &c., constituting the different kinds of granitic, basaltic, and other rocks, or as clay, which is a simple silicate of alumina derived from the disintegration of these rocks.

But silica, as it occurs in sand or flint, is not in what chemists call the state of "soluble silica." By that term they mean that kind of silica which is in an active chemical state disposing it to unite with bases (silica, it should be remembered, being an acid body) to form salts as other acids do. If common sand or powdered flint be strongly heated with an alkali at a certain temperature, the mixture melts and becomes glass more or less transparent—when an excess of silica is employed, the glass is insoluble in water like ordinary glass, but, when the proportion of alkali is excessive, the compound produced is soluble in water—and the solution is that of silicate of soda or potash, according as one or the other alkali has been employed.

If to this solution a sufficiently strong acid is added, a precipitate of a gelatinous character is produced, and this precipitate, which is slightly soluble in water—more so in acids, and above all in caustic alkalies—is called "soluble" or "gelatinous" silica: when dry, it is a white powder of a gritty character, which dissolves with the greatest facility in alkaline solutions at the boiling temperature, and it is rather in relation to them than to any other solvent that this form of silica is called "soluble."

Now if silica in this state be strongly heated it will be found to lose its property of dissolving in alkalies except by fusion—in other words, it will be reduced to the same chemically inactive condition as sand or flint, neither of which bodies can be dissolved to any appreciable extent in solutions of caustic alkalies at the ordinary boiling temperature. There are, therefore, two distinct conditions under which the element silica can exist in the uncombined state—the inactive or insoluble, and the active or soluble condition: sand and flint are, under ordinary circumstances, in the first, and silica, when prepared as before described, or by other artificial processes, in the second.

Flint can indeed be dissolved in alkaline solutions in high-pressure boilers, and consequently at an elevated temperature; whilst quartz rock or white sand, which are other forms of more or less pure silica, cannot be dissolved by these means, or at all events not at the temperature which will dissolve flint.

We have here, then, another condition of silica, making three varieties in all, possessing different degrees of chemical intensity, as evidenced by their disposition to combine with alkalies—

1st. Soluble gelatinous or chemical silica, which readily dissolves in boiling solutions of potash or soda.

2nd. Flint, which does not dissolve to any considerable extent in boiling alkalies at the ordinary temperature, but which can be made to dissolve in such solutions when by means of a steam-tight boiler a temperature of about 300° Fahr. is obtained. And

3rd. Quartz rock or sand, which will dissolve neither in the one case nor the other.

Up to this time, although familiar enough with the two latter forms of silica, we have only known the first as an artificial production, derived in fact by chemical processes from one of these. It has not been known to exist in any quantity as a natural product. It is well, by the way, before leaving this part of the subject, to explain to our agricultural readers that, although clay contains silica, and this silica is in combination with alumina, and may, by certain treatment, be separated from the alumina in the soluble condition, it does not *exist* in the clay in that condition and cannot be employed as a source of soluble silica. Caustic alkalies dissolve out from clay a small portion of silica, seldom, however, amounting to more than 1 or 2 per cent.; the great bulk of the clay remains unacted on until by digestion with acids a separation is effected between the alumina and silica, when the latter becomes soluble in alkalies and is then in the chemically active state. We hope that this explanation will be sufficiently clear and explicit to enable our readers to understand that, although silica is abundant enough on the surface and in the bowels of the earth, soluble or chemically active silica, as described by us, has been hitherto unknown, except as an artificial product.

It is our pleasure to lay open to all whom it may benefit an abundant and accessible source of this substance; and inasmuch as a new material will very soon find numerous and important applications, so a modification of a substance already well known, but which by such modifications becomes in fact a new substance, offers to those who will rightly employ it, opportunities of accomplishing that, which before its discovery would have been impossible or impracticable.

It is difficult, therefore, to say what may or may not be the use in the arts to which this new substance may be applied, but we shall here confine ourselves to the endeavour of showing that to agriculture it may probably become eminently serviceable.

Whilst, however, we are justified in claiming for ourselves the merit of having been the first to discover and to examine the beds of soluble silica as they exist in England, and still further to point out the peculiarities of this deposit and the uses to which it might be put, especially in agriculture, it is right that we should state that when our investigation was well nigh complete our attention was drawn to a notice of a similar deposit existing

in France and examined by M. Sauvage, a French chemist, four or five years ago: this silicious bed is alluded to in Knapp's Technology * in these terms:—

"Another variety of Puzzolana, not of volcanic origin, has very recently been discovered by Sauvage in the Dép. des Ardennes. It there covers the clays of the gault, a fossiliferous formation below the chalk. It is of a pale grey or greenish colour, very soft, and, according to Sauvage, is constituted in the following manner:—

Soluble silica (gelatinous) . . .	56
Clay	7
Fine quartz sand	17
Fine grey limestone (chlorite) . . .	12
Water	8
	100"

It is plain, therefore, that the deposit is of the same character and in the same geological position as that which we are about to describe.

This circumstance is interesting chiefly in showing how general must have been the conditions under which the deposit was formed.

We should, perhaps, here observe that the beds or strata in question are easily recognized by their external as well as chemical characters. Those which contain a high per-centage of silica are, when dry, remarkably light, of a fawn or reddish yellow colour, and very soft, except in some instances where the silica is associated with carbonate of lime, as in the building-stone which we shall have presently to speak of. The soluble silica is dissolved out with perfect ease from these rocks (when reduced to powder) by boiling them in solution of potash or soda; and by collecting and washing that portion which does not dissolve, the per-centage they contain is readily ascertained.†

We consider these beds to consist generally of clay, with a greater or less admixture of soluble silica; when treated as above the silica is dissolved and the clay remains unacted on.

We now proceed to describe geologically and agriculturally the beds as they are formed in those localities which we have as yet had the opportunity of examining.

The stratum to which we have to direct attention is that which geologists technically term the "fire-stone rock." It extends *upwards* from the gault to the chloritic bed of phosphatic marl, described by us in vol. ix. But although this term applies to a stratum which in some places is from 100 to 150 feet and upwards in thickness, it varies greatly in depth, being in some places not more than 4 feet: its subdivisions also exhibit considerable diversity in their lithological character. *Locally*, too,

* Extracted we believe from the 'Annales des Mines.'

† For more accurate results the silica must be precipitated by acids from the solution in the way usually practised.

much difference will be observed in the chemical components of the rock, illustrations of which will be seen in the analyses which follow. Any good geological map will indicate the outcroppings of this rock under the generic appellation of "fire-stone."

The escarpments of the north and south downs of Kent, Surrey, Hampshire, and Sussex, and those of the chalk hills of the Isle of Wight, give the best display of this stratum. Throughout these districts there are two beds which receive from agriculturists the local name of "malm" or marl; viz. the "grey marl" described in vol. xii. of this Journal, which lies *above* the phosphatic bed of green marl, containing a high per-centage of carbonate of lime; and the soft brown rubbly rock, lying between the gault and the harder portion of rock. This harder rock constitutes the true fire-stone. In some localities the lower malm contains very little, in others, no carbonate of lime. Confining ourselves for the present to the above districts, we will give as brief an abstract as possible of the observations of ourselves and others relative to the fire-stone rock as a whole, commencing at Folkstone in Kent and following the escarpment of the north and south downs, till we meet the sea again at Southbourne in Sussex; and thence afterwards to the Isle of Wight. But we think it not amiss to remind our readers that the *boundaries* of this stratum are unmistakeable, viz. the gault, or black-land, as it is sometimes termed, and the bed of green fossiliferous marl below the lower chalk.

At Folkstone the fire-stone rock, exclusive of the chloritic bed of marl, is not more than from 10 to 20 feet in thickness. It follows the escarpment of the chalk hills through Hollingbourne, Maidstone, Wrotham, and Godstone, and thence to Merstham in Surrey. At the latter place, according to Dr. Fitton, the thickness ranges from 60 to 80 feet. From Merstham to Farnham the upthrow is nearly vertical, consequently the development of the several strata is greatly obscured by detritus. But from the centre of the parish of Farnham through Bentley, Binsted, and the intervening parishes, through Selborne to Petersfield in Hampshire (the dip of the strata being small), there is a widening expanse of this rock in the main agreeing with the inclination of the present surface soil; so that from Farnham to Petersfield there is a superficies of several square miles of this silica rock, with a depth of from 50 to 200 feet.

Perhaps it may be as well here to notice the description Dr. Fitton gives of the upper greensand at Farnham, as he there describes a section given by the present writers, which is in fact a portion of Mr. Paine's land whence our lot of specimens was taken:—

"The upper greensand forms a slight prominence beneath the chalk, on the south of Dippen Hall House, between the words 'Dean's farm' and 'Ridg-

way' on the Ordnance map, the strata dipping not much more than 5° to the north. The rock, which is there called 'Marlstone,' does not precisely agree with any I have seen between this place and the coast, but is very like some of the strata in the corresponding place at East Knoyle, on the north of the vale of Wardour. It is a sub-calcareous sandstone, or variety of 'firestone,' very soft, uniform, of a yellowish-green, or cream-colour, scarcely effervescent, and remarkable for its lightness; and it includes concretions of a hard splintery limestone, approaching to chert, and of much greater density than the stone which surrounds them."

The "chert" here alluded to consists of masses of the blue building limestone which occupy the upper part of the series. The chert of the Isle of Wight and elsewhere has a more flinty appearance than this rock, which is indeed a true limestone.

From Farnham to Petersfield there occurs the greatest expanse of the gault and the firestone rock anywhere to be found in this kingdom: and this silica rock occupies, as above stated, a surface of several square miles. To the readers of this Journal it will be unnecessary to recapitulate the outcropping of these strata below the ranges of the Chalk Hills, as they are fully detailed in our paper on the Phosphoric Strata of the Chalk Formation, vol. ix., page 56 to 84, and in the publications therein referred to. The chalk, marl, and underlying firestone, or silica rock, are there generally described as follows. Then our object was to describe the *phosphatic* beds of this remarkable deposit; now it is to supply more definite information than has hitherto existed of its *silica* beds :—

"Immediately below the soft marl bed the first division of the greensand formation commences, viz. the upper greensand and firestone rock. It commonly comprises three distinctive subdivisions. The first is a thin green band of marl, more or less silicious, abounding in organised fossil remains; it lies below, and is in contact with, the soft dirty white marl above mentioned. In thickness it varies from a few inches to 10 or 15 feet. To this division the attention of agriculturists is particularly invited, it being most remarkably rich in phosphate of lime. It rests upon a rubbly mass of broken-up rock, from 10 to 20 feet thick, which is also impregnated with a notable quantity of phosphitic matter. In this lower mass are nodules of a purely white substance, thickly interspersed, which, with the peculiar green colour of the bed above them, may be serviceable as a means of identifying the stratum in different situations.

"The second subdivision is the firestone rock, or building-stone. Its thickness is extremely uncertain; in some places consisting merely of one bed of stone, while in others it forms a series of layers, the aggregate thickness of which reaches to nearly 100 feet, as, for example, at the Undercliff of the Isle of Wight. This rock becomes softer in its lowest position, and gradually merges into a soft clayey marl, which constitutes the third subdivision. This again, in its inferior parts, becomes more and more argillaceous, until it is finally lost in the gault or blue marl stratum."

The valleys of Wardour, Warminster, and Pewsey, in Wiltshire, have considerable outcroppings of the firestone rock. These tracts all possess a high reputation for their agricultural fertility, but we have not had an opportunity of examining the constituents of the rock from these localities.

Our attention was first called to the examination of this bed of rock, as it formed externally an easily distinguishable member of the "chalk-marl series," and was consequently selected for investigation. Its peculiar physical properties, viz. its friability, its low specific gravity, its porosity, and consequent mechanically absorptive power, were very striking, especially as it has been very largely applied to the covering up of dung-heaps during several years, besides having been extensively used as a direct manure with signal benefit on the upper chalk soils, as well as on some very sandy lands. For this purpose it has been carted to distances of from two to three miles, both to the north and south of the quarry. In addition to these circumstances we had long known the outcroppings of the "malm" to be naturally (that is, when not obscured by want of drainage or by other bad cultivation) of the most fertile character, constituting, as we have stated in our former papers, some of the very best hop and wheat lands in the kingdom.

On the south-west of the parish of Farnham there is a large development of the gault and upper greensand in juxta-position, forming a succession of outcrops near the surface, which is chiefly comprised in Mr. Paine's farms called "Dippen Hall" and "Deans" in the Ordnance maps. The whole stratum between the gault and the grey or dirty-white marl (No. 7, vol. xii.) is about 100 feet thick. It invariably assumes a rocky appearance on receding from the gault, getting rid more and more of its argillaceous character till the rock stands out distinctly, though still of a very soft friable nature, crumbling into powder on exposure to the weather. This is the portion that has been quarried for manure. It contains from 25 to 30 per cent. of soluble silica, and occupies a central position in the whole stratum. The range between these two percentages is from 30 to 40 feet in vertical depth. Ascending from this middle portion of the stratum it gradually assumes a more compact form of rock, which contains from 30 to 70 per cent. of soluble silica. There are, however, intermediate layers of softer earth, which we find have invariably a lower percentage of silica, as, for example, No. 23, in Section III., between 24 and 25; and No. 72, between 71 and 73, in Section I. We now approach the true firestone, in some cases with, in others without, carbonate of lime. Here, however, it differs from the firestone of Merstham and the Isle of Wight, in having none of the green grains which are so thickly interspersed in these districts. There is usually one—oftentimes two beds of the blue limestone running through the firestone. This is a most excellent building-stone. The highest percentage of soluble silica yet obtained is from a layer about 10 feet thick and 15 feet below the firestone: here from 70 to 75 per cent. may be procured. From this culminating

point through the firestone, rubbly rock, and phosphatic green marl, to the "grey marl" above, there is a gradual declension of soluble silica as the analyses will indicate.

The above facts were ascertained by cutting two trenches respectively about 200 and 400 yards long down to the true geological subsoil in two fields in Dippen Hall and Deans farms, about half a mile apart. These two sections give similar indications and were corroborated by the marl pit in Crondall-lane, about three quarters of a mile from the nearest of the other sections.

In these sections the dip to the north-west is about 20 degrees, and the valley being denuded in the opposite direction gave us a good opportunity of obtaining accurate results. The samples were taken whenever a change in the aspect of the subsoil was remarked. In only one instance below the firestone did we find a layer containing carbonate of lime ; this was about 4 feet thick (No. 31 in Section II.). We have, however, subsequently noticed a similar layer at Selborne.

I.—South-West Section, at Farnham.

From Deans Bottom and Hanger, in "Deans Farm," over a surface of about 380 yards, from south-east to north-west.

No.	Silica.	Carbonate of Lime.	Remarks.
13	2·34	..	Near the gault, approaching a clay in appearance.
75	16·03	..	Soft rock which readily crumbles into dust.
42	27·81	..	Rather harder.
12	37·01	..	Slightly harder, though still a crumbling rock.
22	58·88	..	Hard, but very light and porous.
41	41·73	..	Softer rock, like 12 in texture.
40	43·73	..	About as 41.
37	40·56	..	Ditto.
36	47·55	..	More compact, rather hard.
19	58·67	..	Hard like 22.
71	66·75	..	Hard and rather cherty looking.
72	43·94	..	Very soft stratum, like marl, 4 feet thick, lying between 71 and 73.
73	58·45	..	Hard layer of rock below 72.
39	72·00	..	Hard, compact, light rock, 10 feet thick.
78	58·52	..	Brittle rubbly rock below 39.
37	40·56	..	Softer.
36	47·55	..	About as 37.
77	8·20	74·96	Blue building limestone.
76	56·62	..	White building-stone, or "firestone," 20 feet thick.
48	40·75	20·86	Rotten stone above 76.
49	13·26	62·22	Thin flaky stone, lying above 48.
..	29·14	..	Green marl.
..	1·82	65·52	The "grey marl" referred to in the text above, which terminates the series.

In the above section we consider the vertical depth of the rock, from Nos. 42 to 48 inclusive, to be upwards of 100 feet.

II.—Middle Section.

From "Hook," in "Dippen Hall Farm," over a surface of about 200 yards, from south-east to north-west.

No.	Silica.	Carbonate of Lime.	Remarks.
68	13·41	..	Very soft dirty-white "malm," near the gault.
33	18·07	..	Approaching to a rocky character.
32	15·98	..	Ditto.
53	15·27	..	Ditto, dug out 6 feet deeper than 32.
31	30·76	28·09	Hard rock, with blue marks, about 3 feet thick. The only specimen in which a large quantity of carbonate of lime is present in the middle part of the section.
30	38·31	..	Soft rock.
29	40·16	..	Harder rock.
28	49·81	..	Still harder.
28*	29·67	..	Soft marly stuff interspersed with the hard rock.
27	44·41	..	Rather soft rock.
62	48·32	..	Hard rock.
11	53·01	..	Ditto.
54	43·83	..	White building or "firestone."

These, like section I. to the grey marl. The vertical depth from Nos. 33 to 54 inclusive is about 70 feet.

III.—North-East Section, in Crondall Lane.

No.	Silica.	Carbonate of Lime.	Remarks.
10	6·14	..	Near the gault.
59	32·20	..	Soft rocky texture. These are all similar in appearance as well as in the analytical results. They constitute a layer of about 40 feet in thickness. This also is the part that has been so extensively quarried for manure.
58	35·30	..	
50	29·24	..	
9	27·86	..	
9*	30·00	..	
9**	33·88	..	
51	31·04	..	
23	23·36	..	Very soft stratum 3 feet thick.
25	59·79	..	This rock occupies a relative position to No. 39 and No. 11 in the preceding sections; Nos. 39, 11, and 25, being the respective culminating points.
60	54·54	..	The white building or "firestone." The blue limestone is here absent.

Vertical depth of this whole Section about 60 feet.

We believe that the above description will generally apply to the district between Farnham and Petersfield, though the whole strata and their subdivisions will vary considerably in thickness. In many parts, too, of this district, the strata are nearly horizontal, and in these cases when the rock is near the surface the land requires drainage, as the rock acts like a pavement to obstruct the water in its downward passage. This, combined with many instances of careless farming, precludes the development of the intrinsic fertility of this soil.

The following samples are from the land of Sir A. K. Macdonald, Bart., at Selborne, in Hampshire :—

No.	Silica.	Carbonate of Lime.	Remarks.
1	45·41	. .	A light yellow rock, very similar to No. 73.
2	55·68	. .	White rock, analogous in position to No. 39.
3	26·80	13·30	Resembling No. 31.

A piece of firestone rock, from Merstham in Surrey, was found to contain 40 per cent. of soluble silica.

We have recently visited the Undercliff of the Isle of Wight for the purpose of examining these strata, and of obtaining specimens for analysis. As a whole, they are much more heavy and indurated than in the neighbourhood of Farnham, and generally exhibit too a more sandy-looking structure. We judge that the whole section we took was about 170 feet thick—that is, from the gault to the grey marl above the green phosphate bed, which always shows itself very conspicuously. The gault is trifling as compared with that near Farnham. *Immediately* above the gault, the "malm," as it is here termed, has a hardened rocky appearance (8), and is somewhat discoloured by contact with the black gault below; about 10 feet above it assumes a light brown or cream-colour (7), which gradually becomes more compact, forming huge masses of rubbly stone, altogether 30 feet thick; above this there is a mass of rock 25 to 30 feet thick, very similar in appearance to, though heavier than, the high percentage silica layer at Farnham (6). This bed is continued upwards perhaps 40 feet more, but is interrupted by several thin seams of "chert" or compact flint. We now arrive at the freestone of the island, one bed of which is well worthy of notice, as forming the principal building-stone at Ventnor. It is called "the Freestone" (4). It is easily sawn when dug, and hardens on exposure to the weather. It occupies one continuous layer between 4 and 5 feet thick, lying between two other beds of "false freestone" (5), of about the same thickness, being separated from each by a seam of blue limestone. These thin beds, therefore, are about 15 feet thick. Above this there is a rubbly bed of rock used chiefly for building rough walls, &c., about 20 feet (3). Thence upwards to the chloritic bed of phosphatic marl, from 30 to 40 feet, there are thin beds of the silica rock interlocated with seams of blue limestone (2) and cherty flint (1). These thin layers of compact limestone and chert give rise to the weathered protuberances of the upper part of the Undercliff, for they resist to a great extent the decomposing influence of the atmosphere,

while the silica rock moulders away, leaving the terraces above in bold relief. This simple cause adds greatly to the beauty of this most beautiful part of the Isle of Wight.

The green marl bed above, which is the upper member of the upper greensand, is here from 8 to 10 feet thick. Altogether, therefore, the stratum, where we examined it, may be considered about 170 feet in thickness.

SECTION from the Isle of Wight.

No.	Silica.	Carbonate of Lime.
1	3·11	1·34
2	1·71	66·00
3	2·82	5·80
4	3·20	14·04
5	5·94	12·54
6	9·64	8·75
7	8·56	12·50
8	4·84	8·30

Our readers will perceive, by comparing the analyses of this section with those of Farnham, &c., that the silica strata of the lower chalk in the Isle of Wight are not likely to furnish an adequate source of *soluble* silica either for manufacturing or agricultural purposes. We believe that the deposit in the Isle of Wight has been subsequently altered by volcanic heat.

The agricultural properties of this silica rock have never received much attention until the present inquiry. It is, however, a well-recognised fact that the "malm" districts have long been celebrated for growing fine crops of wheat, both as regards quality and quantity. Mr. Paine has grown enormously large crops of the best white wheat on this soil when in a high state of cultivation, and they have been remarkable for the stiffness of the straw. Until recent improvements in wheat-growing were more generally practised, the malm soil of Hampshire was highly esteemed for its seed wheat, and a very extensive district was supplied with seed from this source; thereby evincing that, without the aid of artificial appliances, many parts of these soils give excellent crops. Since we became acquainted with the peculiar properties of this rock we have made diligent inquiries of the farmers upon the "malm" soils, and they invariably agree in their testimony that the application of lime once in about ten years, at the rate of a bushel to the rod, or 160 bushels to the acre, is of most essential benefit—not only in the increase of their crops, but more especially in stiffening the straw of the cereals, and in improving the quality of the corn and increasing the weight per bushel. Lime has been, and still is, extensively used in these parts; and, as stated by all the farmers, with about the same apparent advantage on the gault as on the silica rock. On the other hand, bones have been tried again and again on these soils with no perceptible profit to the crops,

whether of corn or turnips. Gypsum, too, upon seeds is a manure always used with great success upon the soils of the malm rock; while upon those of the gault it produces no effect whatever. The latter result we should have anticipated, as our investigations have led us to discover an abundance of crystallized sulphate of lime in the gault clays.

From the foregoing description it will, we hope, be gathered that, in certain parts of the country, and especially in parts of Surrey and Hampshire, there occur at the base of the chalk formation, and immediately above the gault clay, large deposits of silica in the soluble condition. The silica is mixed with ordinary clay in different proportions, and with these two ingredients a third, carbonate of lime, is associated in some of the beds. The percentage of silica varies from 5 per cent. up to about 70, or somewhat more. Of this highest percentage a large quantity could with ease be obtained, but we may safely assert that it would be practicable to quarry many hundreds of thousands of tons, containing as much as 60 per cent. Twenty or thirty tons were sent to London for the purpose of being made into manure, and upon being ground up the bulk was found to average 64 per cent. of soluble silica.

We believe then—and, having taken very active and effectual measures to settle this point, we are justified in believing—that, for any purpose, agricultural or manufacturing, any quantity of this earth that could by possibility be required could be supplied from Farnham and its neighbourhood.

It becomes us next to inquire in what way a supply of soluble silica can benefit, or be made to benefit, practical agriculture.

The direct use of alkaline silicates as manure has not hitherto been extensively tried in this or other countries. What little experience of the effect of silicate of potash or soda we do possess is not remarkably favourable to their employment. Still the difficulty of manufacturing the alkaline silicates in a proper form, and the great expense of these salts, has quite precluded a fair trial of their merits as manure. We do not think, then, that the question of the use of soluble silicates as manures for cereal crops is by any means settled.

The discovery of this bed of soluble silica offers facilities for the production of silicates of soda and potash, of which the manufacturer of these salts will assuredly not be slow to take advantage. It is another and an ulterior question whether, when, by moderate price and proper form for application, they are brought within his reach, the farmer can make an advantageous use of them.

We will, however, shortly state what facilities we consider these beds to furnish for manufacturing silicates. The great

difficulty and expense of making alkaline silicates for agricultural use arises from the necessity of *fusion* of the materials at a high temperature. The process is essentially a glass-making process, but, in addition to the ordinary costliness of the operation, the excess of alkali necessary for making *soluble* glass is exceedingly destructive to the pots and kilns.

The silica rock of Farnham may be made to combine with soda or potash in two or more ways without fusion—either,* first, by boiling it with caustic potash or soda for a short time, when the silica dissolves, and the solution can be separated and evaporated to any required strength, or to dryness; or, secondly, by heating the rock with a proper proportion of crude carbonate of soda at a gentle temperature in a reverberatory furnace. No fusion occurs, or is necessary, since, from the nature of the silica, its perfect combination with the soda takes place at a very low temperature.

In this latter process (which would be by far the most economical) the alkaline silicate is at once obtained in the dry state. It would of course not be pure, being mixed with the clay of the silica rock; still, if it became an article of commerce, it would be sold, like other such impure compounds, at its fair value in real silicate. We believe, then, that if silicate of potash and soda are wanted for agriculture, we have at length an easy and economical method of obtaining them.

But in either of the above salts it is the silica principally, and not the alkali, that is needed, and for which the silicate would be used in agriculture; and we shall have made a great advance if we can substitute for the costly alkalies, potash and soda, a cheaper substance to unite with the silica, such as lime.

If there is a difficulty in making soda and silica unite, and a necessity for a very high temperature, much more is this the case with lime; and, further, silicate of lime, when so formed, would not be of any use to agriculture, because it is insoluble. We have, however, quite overcome this difficulty by the discovery of the silica rocks of Farnham.

If to a solution of lime—that is to say, to ordinary lime-water—you add a quantity of pure soluble silica, and agitate it for a short time, you will find (by proper tests†) that the greater part of the lime is removed, and that what still exists in the solution is not in the condition of caustic lime, but of silicate. The action is much more rapid if heat is applied.

If, instead of using lime-water, we employ slaked lime with

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* It is easy to make the alkali take up in this way two equivalents of silica, or, in the case of soda, three times its weight.

† Nitrate of silver gives a brown precipitate with caustic lime, but when all the lime is converted into silicate the precipitate is pale yellow or white.

silica in the proper proportions (to be mentioned shortly), we get the same thing happening—the lime successively dissolves and unites with the silica, till the combination of the whole is accomplished. Now, the silica of the Farnham rocks is happily in this same active condition—it can be made to unite with lime in several ways, and with the greatest ease; and when formed with the proper precautions, the silicate of lime is soluble in water, not to a great extent, but sufficiently so, as we believe, for all the purposes of a manure.

We shall describe the various ways which we have tried in making silicate of lime, in order that any person who wishes to make this salt should do so in the manner which may be most open to him :—

1st. Slaked lime is to be mixed with the silica rock in fine powder, in such proportion that the free soluble silica shall be to the weight of lime before slaking as 5 to 1; consequently, if the silica rock used contains 50 per cent. of soluble silica, 10 parts of it will be necessary for every 1 part of quick lime, and so on. The mixture, being made into a puddle with water (in such quantity that it will be thoroughly moist without being so thin as to separate), is to be left for a few weeks or a month, when combination will be in great part or altogether effected. We cannot state exactly what time will be necessary for this purpose, but we have reason to think that, for all ordinary purposes, a sufficient amount of action would be developed in one or two months. As the change goes on, the materials dry up, from uniting, as plaster of Paris does, with the water. It is desirable to keep them moist to a given extent; but, for a manufacturing process, the object should be to hit that quantity of water which, by the time combination was effected, should have been nearly all absorbed or dried off, so that the mixture might be ready for use or for transportation to a distance.

2nd. The same ingredients as the last, with the addition of a little common carbonate of soda (about 2 per cent. of the weight of the lime and silica rock). This carbonate of soda is to be dissolved in the water; it soon becomes caustic, and, by dissolving the silica, which it afterwards gives up to the lime, and then commencing again, it speedily converts the whole of the lime into silicate; its office, therefore, is as a carrier between the two, and it greatly expedites the process.

3rd. The materials as in the last cases, but the lime ground finely, but not slaked. The slaking of the lime *in the mixture* gives much heat, which materially assists the process. Still better will it be if the water can be at the boiling temperature, when the heat, in a large mass of materials, would be retained for some time, and days would do the work of weeks.

4th. The materials, lime and silica rock, in the same proportions, and with water, may be made to combine in one or two hours at or near the boiling point. There is no need of ebullition. A mixture — thicker than gruel — might be heated by steam-pipes in vats, and the process would be simple and inexpensive. It is advisable to have as little water as can be made to serve the purpose, because there is then less trouble in drying the product.

This is the process which we prefer, as giving the best results, with a certainty of none of the silicate of lime becoming insoluble, as may happen in the processes now to be described.

5th. Silica rock and carbonate of lime (chalk) heated in the dry state. The silica rock must here be in such proportion to the chalk that there may be three times as much soluble silica as chalk. Consequently, if the rock contains 50 per cent. of silica, we must use six parts of it to one part of chalk. These, being ground together and well mixed, are to be heated to a gentle dull-red heat in a reverberatory furnace. Combination readily takes place; and the silicate of lime, which, when it comes out, will crush down to a fine powder under the fingers, is admirably adapted for drilling or broadcasting. The great point here is temperature: it must be sufficient to change the carbonate into silicate; but, if it goes far beyond this, the silicate *becomes insoluble in water*, and is then useless, or comparatively so, for the purposes we have in view. We believe that there is plenty of margin between these points for a careful manufacturer, and there can be no doubt that he would prefer this under most circumstances to the methods before described, but, if adopted, the greatest caution must be used in its employment.

A 6th process consists in employing quick lime instead of carbonate (chalk) in the operation. The heat required is still lower, and there is therefore less fear of overheating. The expense will be rather more, of course, but would hardly materially increase the cost of the product.

Having described rather minutely the methods of making silicate of lime from this silica rock, we pass on to mention its properties and probable uses in agriculture. Silicate of lime is slightly soluble in water. The result of several experiments which we have made is, that the solubility reaches about 20 grains in the imperial gallon. Of this quantity, three-fourths, or 15 grains, is silica. Compared with other salts, even with those which we are in the habit of considering as insoluble salts, this is certainly a very slight degree of solubility; but there is every reason to believe that it is sufficient for the requirements of vegetation; and it is consistent with what we now know of

vegetable nutrition to believe that the least soluble salts (so that they be soluble in some measure) are the most adapted for the supplying the mineral matters of plants. The quantity of water passing through a plant, and expaled by its leaves, during the period of its growth, is very great. From some experiments made by Mr. Lawes on this subject, we may infer that a wheat crop exhales in its growth as much as 230 times its weight of water; and it is plain that this water must be charged with the soluble matters of the soil.

Silicate of lime, like many other slightly soluble salts, is more soluble in solutions of other salts than in pure water. For instance, in a weak solution of common salt it dissolves to twice the extent that it does in plain water: it is also much more soluble in water containing carbonic acid. But, calculating the quantity dissolved by water only, we should find that, during the growth of a crop of wheat or barley, enough silica might be introduced in the form of silicate of lime for the necessities of the plant.

We believe, therefore, that such silicate of lime will be found to be sufficiently soluble for agricultural use. At the same time its value as a manure can only be ascertained by practical experiment.

It is notorious that the growth of wheat is chiefly uncertain on light sandy or peaty soils; the difficulty is not so much the production of the plant as that of bringing it to maturity, and preventing it from being lodged or laid before harvest. This condition of the plant is usually attributed to a deficiency of silica in the straw; and although there is no very good evidence to prove that the quantity of silica is actually less in such straw than in that which is strong and bright, it seems very reasonable to suppose that a want of silica, or indeed of any other of the necessary ingredients of the plant, would lead to an unhealthy and immature state, and indirectly we should therefore be right in referring the evil to such a cause.

We have observed that silicate of lime has the peculiar property of decomposing ammoniacal salts. When mixed, for instance, with sulphate of ammonia it causes an instant disengagement of ammonia, in the same way, though in a much less degree, than caustic lime itself would. The change that occurs here is the formation of sulphate of lime and silicate of ammonia; but the latter, being a very weak salt, breaks up quickly into free ammonia, which escapes into the air, and silica. If the solution of silicate of ammonia is very weak, however, this decomposition of the silicate of ammonia does not appear to occur.

It is very probable that silicate of lime may in this way serve an important purpose in light soils. If, as Mr. Way has urged in former papers, crude ammoniacal salts are positively injurious

to plants, and that in good loamy soils they are modified and changed into slightly soluble silicates, it will evidently be an approach to this condition, if in light soils we can induce the conversion of the different salts of ammonia into the form of silicate of ammonia, which is believed to be the actual form in which in good soils it is presented to the roots.

The simple silicate of lime of which we are now speaking must not be confounded with the compound form—silicate of lime and alumina: this latter actually, as we have before seen, separates and renders insoluble the ammonia of manure; silicate of lime will not do this, and it cannot be looked to as a means of making light land more *retentive* of manure; but if, as we hope, it should be found to render the use of nitrogenous manures, such as guano, &c., more safe on light land, and should facilitate the growth of large crops on such lands by the use of abundance of manure, a great advantage would be obtained for the agriculture of this country. We think, therefore, that silicate of lime is well worth trying as a means of brightening and strengthening the straw of cereal crops on light land, and of checking the over luxuriance due to high manuring. It might be made very cheaply—probably at a cost of less than 3*l.* per ton—and from 2 to 3 cwt. would be a sufficient application per acre. It might be applied either in the autumn or as a top-dressing in early spring; but, from its comparative insolubility, it would be better to have it well diffused through the soil, and therefore the autumn would probably be the best time for applying it.*

We have already mentioned the advantage obtained by the application of lime on those lands where this rock shows itself near the surface: for the districts where it is easily obtained it may be often desirable to apply the silica marl with lime, either separately or at the same time, trusting to the combination taking place in the soil. Where lime-kilns exist in these districts, a very easy method of forming the silicate would be to heat gently the building-stones (Nos. 54, 60, 76, 77) which we have described as containing carbonate of lime mixed with soluble silica. The burning will be effected in the same way as that of common chalk, but at a lower temperature.

The discovery of these silica beds brings us a great way nearer

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* On the 12th April in this year, upon some wheat grown on a gravelly soil, resting upon the lower greensand, naturally poor but well cultivated, and manured with dried blood at the rate of 5 cwt. per acre, was applied on 10 perches 28 lbs. of the double silicate of alumina and ammonia; two perches were then missed, and on another 10 perches 60 lbs. of silicate of lime was applied; two perches were again missed, and on a third plot of 6 perches 39 lbs. of silicate of soda was applied. At this time (8th June) all the three plots are manifestly better than the unsilicated portions, the straw being from 4 to 6 inches higher, and not quite so dark a colour. —J. M. Paine.

to the practical production of the double silicates for agricultural use, but we shall probably have to return to this subject in a future paper. We have only further to add one or two remarks on the formation of this silicious deposit. It is not infusorial; for, with the exception of a few foraminifera, no traces of animal life can be observed in the rock by microscopical examination. It cannot have been subjected to heat of any intensity, or it would have been rendered insoluble in alkalies. It is plainly the result of aqueous decomposition; and it seems very reasonable to suppose that silicate of lime in solution, derived from the older rocks, may have met with carbonic acid, produced either by vegetable and animal decay, or by volcanic agency, and at one and the same time carbonate of lime and gelatinous or soluble silica would be formed. It should be remembered that we find these beds in immediate contact with the chalk. We find chalk without silica—silica without chalk; and in other cases, as in the building-stones, we have both intimately blended. There is, therefore, very good reason for supposing that these productions have been in some way connected.

This is a speculation, however, of no great interest to the agriculturist, and we shall not carry it farther in this place.

We think it right to state that the subject is by no means exhausted; but having given the results of our investigation up to the present time, as it is obviously connected with many important agricultural questions, we shall probably give an account of our extended inquiries on a future occasion.

" *Alton*, *June* 10*th*, 1853.

" My dear Sir,—A pressure of different professional matters has prevented my attention to your request before. I inquired of Mr. Wm. Pamplin, of River Hill Farm, at Binsted, as to the effects of lime on the *malm* lands in his occupation at that place. He states as follows:—

" ' The beneficial effects of lime as a dressing on the malm lands would scarcely be credited if not seen: there is no dressing like it. The lime I have applied was white lime from chalk procured at Foyle—white chalk with flints. I have usually applied 1 bushel per rod, and its effects are perceptible for 8 or 10 years; it can be seen to an inch where it has been laid by the luxuriance of the crop, and it can even clearly be perceived where the *dust only* has settled when the dressing was applied to other land. In one field of mine a small part was missed in the last season—the wheat failed on that spot of the field only. I am certain there are 500 blades on the limed part to every 100 on the part not limed.'

" Mr. John Waterman, of Norton Farm, Selborne, in answer to similar inquiries, states as follows:—

" ' Part of the land in my occupation is malm land, on which I apply a considerable quantity of lime, which works well, particularly for green crops, and makes the *berry* of the cereal crops much finer. I have used it on the clay lands, but with little advantage. The lime I use is made from the chalk of Noah Hill—principally white. There is grey chalk under the white at

Noah Hill, which makes better lime for building purposes, I think. I had seen no experiment tried till last year, when I used lime from this grey chalk; at present I cannot see any difference in the effect—there are flints in each sort.'

"If I can make any further inquiries for you, I shall have pleasure in doing so.—I remain, my dear Sir, yours very truly,

"*J. M. Paine, Esq.*" "JAMES W. CLEMENT.

XIX.—*Second Report on the Prevention of Pleuro-Pneumonia in Cattle by Inoculation.* By Professor SIMONDS, Veterinary Inspector to the Society.

IN the former Report which we had the honour of submitting to the Council of the Royal Agricultural Society on the subject of inoculation of cattle as a preventive of Pleuro-pneumonia, we drew attention to the proceedings which had been adopted on the Continent, and more particularly in Belgium, towards establishing this method of imparting security against that insidious and fatal disease. From the great interest which this subject has excited both on the Continent and in England, it becomes necessary to repeat in this place that the plan of inoculation originated with a Dr. Willems, of Hasselt, who was induced to practise it after giving trial to various other measures; all of which had failed to arrest the progress of Pleuro-pneumonia. Dr. Willems' experiments date from December, 1850, but they were chiefly carried out during the years 1851 and 1852, and were at first made on animals belonging to his father—a distiller and large proprietor of "fatting cattle."

With the introduction of inoculation the attacks of the disease rapidly diminished, and, it being considered that this beneficial change depended entirely on the employment of inoculation, Dr. Willems lost no time in calling the attention of the Belgian Government to the subject. The immediate effect of this step was, as stated in our former Report, the appointment of a Government Commission, consisting of both scientific and practical individuals, to investigate the merits of this new preventive system. This procedure on the part of the Belgian Government led, as was to be expected, to similar Commissions being instituted by other Governments, thereby giving a worldwide fame to the subject of cattle inoculation.

Perhaps, of late years, few things connected with the diseases of cattle have excited so lively an interest or led to more numerous experiments than this supposed preventive of Pleuropneumonia. Under such circumstances it was not unreasonable to hope that, ere this, the question of the propriety of

inoculation would have been both *finally* and *satisfactorily* set at rest. It appears, however, that such is far from being the case, and the subject seems destined, for a time at least, to hold its place among the *questiones vexatæ*. Men of equally great repute in the science of medicine are to be found ranked on either side, as its advocates or its opponents.

Reserving for the present the opinions which have been formed from our own experience in inoculation, we shall proceed to give the conclusions of other investigators. This becomes the more necessary, as in many particulars a want of agreement would seem to exist *even in the results themselves* of the operation, and hence probably the cause of the differences of opinion to which we have alluded.

First, in order of time, come two Reports from the Dutch Commission, dated respectively September 21st and December 28th, 1852. The details of the experiments are very accurately given, and occupy the greater part of both reports. It is, however, not necessary to quote them here, as they differ not essentially from those to be afterwards mentioned. "The result of the trial," says the Committee, "may be thus summed up:"—

"1st. Although inoculation in pulmonary disease is not, in every respect, a harmless operation, and may produce considerable ulceration, and even death, the symptoms, as a rule, are confined to the part where it is applied.

"2nd. To obviate, as much as possible, unfavourable consequences, it is necessary to use some precaution, as well in regard to the choice of matter as to the time of applying it. The season of the year—the state of the weather—the healthy condition of the animal—may exercise considerable influence. The autumn appears, for several reasons, to be the most fitting time.

"3rd. Where more violent action and dangerous symptoms in remoter organs likewise appear, they may also be connected, excepting in exterior circumstances, with the individual condition of the animal, for which reason they cannot always be avoided.

"4th. When the violent action occurs and extends to the more vital parts, affecting the whole system, its progress can as little be prevented and checked as the disease in general can be cured.

"5th. In those cases where the progress has been serious and even terminated in death, morbid degeneration has never been observed in the pectoral cavity or in the lungs, but as yet only in the cavity of the belly.

"6th. Inoculation, when its effects appear as a local affection, has never exercised any unfavourable influence on the general state of health or on the milk. In those cases only where, on account of previous violent action, fretting ulcerations appear, the animals continue to pine for a while.

"7th. On the procreative impulse it does not exercise any decided influence, being proportionally more prevalent with inoculated than with not-inoculated animals. It is, however, remarkable that it has not occurred with No. 25,* although the regular period is already past.

"8th. The unproductive effects on Nos. 5 and 12, consequent probably on abortion, cannot, as long as these two cases remain isolated, be ascribed to

* This and all subsequent numbers named in the extract have reference to animals alluded to in other parts of the Report of the Commission where the details of each case are given.

inoculation; more particularly as, with Nos. 19, 21, and 23, where considerable action prevailed, it did not occur.

"9th. Although it cannot with perfect certainty be determined whether premature calving of the cow (No. 10) near her time of calving, and the symptoms observed on that cow and subsequently on the calf, as well as the premature calving of No. 14, are attributable to the previous inoculation, it would not be advisable in advanced stages of bearing to apply it.

"10th. Although abortion on the first appearance of the disease frequently occurs, it is worthy of remark that it never occurred with animals where action was so severe as to occasion death (as in case No. 9); so that, if inoculation exercises influence on pregnancy it probably only does so in the last stage.

"11th. The supposition noticed in the first report, that the commencement of the disease after inoculation is only to be ascribed to its having been in existence at the time of inoculation (of which nevertheless not one single appearance has been observed), obtains greater probability from the present experiments.

"12th. The assertion that animals having once had the pulmonary disease and been cured, never, or at least rarely, take the disease for the second time, and that inoculation in such cases remains inoperative, is confirmed in case No. 16, on whom inoculation twice repeated produced no effect. And finally:

"13th. Although the present trials prove in a remarkable degree that inoculation possesses the power, at least temporarily, to prevent infection, it remains uncertain how far disposition for the disease is completely, or only for a longer period, destroyed.

"From the nature of the subject a considerable time must elapse before any positive conclusion can be acquired on this point.

"The Committee has thus endeavoured to make your Excellency* acquainted, as circumstantially and accurately as possible, with the result of its investigation.

"It has entered into extensive detail in order as far as possible to state every particular relative to inoculation and its consequences, with a view thereby, and by a faithful detail of the progress of its inquiries, to remove from the minds of our cattle proprietors the unfavourable impression produced by the rash, or at all events premature, judgment of veterinary practitioners in a neighbouring country, which has been noticed in several newspapers; neither does the Committee, from the result of acquired experience, hesitate to recommend inoculation, under prudent treatment, in every case where pulmonary disease has broken out in a herd of cattle, or in the neighbourhood.

(Signed) "P. H. J. Wellenbergh. I. Jennes.
R. J. C. Rynders. F. C. Hekmeyer.
G. Wit. J. R. E. Van Laer.

"*Utrecht*, *Dec.* 28, 1852."

It will be sufficient for the present to make but one or two comments on these conclusions: and firstly, on "the supposition" contained in the 11th section, to the effect that animals dying of Pleuro-pneumonia, subsequent to inoculation, have at the time of the operation the disease incubated in their systems. This is a point of some importance in the present inquiry, and particularly with regard to protection; for while it admits that Pleuro-pneumonia is a disease which has, like many others, its incubative stage, still it fixes no limit to such stage. We might

* The Report is addressed to his Excellency the Minister of the Home Department.

consequently infer that, in the opinion of the Committee, an attack of the malady, subsequent to inoculation, howsoever remote it may be, would not depend on an exposure to the ordinary causes producing it, but on its being incubated at that time. Indirectly, the committee here assert that inoculation is protective to the animal during the remaining period of its life. That such is not their opinion is seen, however, by the 13th conclusion.

It is unnecessary here to discuss the question of the differences in the period of incubation of different diseases. For the most part they are well understood, and with very few exceptions clearly ascertained; rarely does the time exceed two or three weeks. It is evident, therefore, that the Committee merely desire to give it as their opinion, that Pleuro-pneumonia, if happening within a *very short time* of inoculation, was lying dormant in the system of the animal when the operation was performed. In this view of the subject we can coincide; but this leaves such cases as are named in our first Report,* of animals attacked *two months*, and *three months and a half*, after inoculation, to be accounted for only on the principle that they were *unprotected* by inoculation, and therefore it is an argument against the practice. This question will receive further elucidation from the facts which will be given in the after part of the present Report, and we will only add that no person acquainted with pleuro-pneumonia would be found bold enough to affirm that the disease is incubated, or, in other words, is slowly advancing to maturity, during so long a time as two or three months, and this without the animal exhibiting any indications of its existence.

The only other point in the report of the Dutch Commissioners necessary to allude to here is found in the concluding sentence, where the Committee observe that they do not "hesitate to recommend inoculation under prudent treatment in every case where pulmonary disease has broken out in a herd of cattle or in the neighbourhood." Would that our own experience enabled us to say the same: for the present, however, we must leave the opinions and the recommendations of the Committee, and pass on to show what conclusions have been come to by other continental investigators.

In our first Report it will be seen that allusion is made to certain causes which induced the Government of Prussia to delay its official inquiry into the subject. Subsequently, however, it commissioned Dr. S. Ulrich, Veterinary Professor of the Royal Academy at Möglin, to proceed to Hasselt, and to report

* See Journal, vol. xiii. p. 382.

the result of his investigations. We are unable to give the full particulars of the experiments had recourse to by M. Ulrich on his return, or the conclusions to which he arrived, but that he reported upon the whole in favour of inoculation may be gathered from the following letter sent to the Earl of Clarendon by Mr. J. R. Curtis, Her Majesty's Consul at Cologne.*

"*British Consulate, Cologne, March* 11, 1853.

"My Lord,—Since I had the honour last year of bringing under the attention of Her Majesty's Government the great importance of the recent discovery made by Dr. Willems, of inoculating cattle as a preservative against the Pleuro-pneumonia, or commonly known in England under the name of the "new disease," by the virulence of which thousands of cattle are carried off annually, and against which all medical aid has up to this period proved insufficient to check its infectious ravages, I have not lost sight of this important question, and the various improvements which longer experience has introduced into this new system; and I consider that I should be failing in my duty if I did not call your Lordship's attention to a report which has been forwarded to me upon this subject by Dr. Sticker, Royal Veterinary Surgeon for the district of Cologne, a translation of which I now beg leave most respectfully to enclose.

"As a Committee has been appointed in London for the investigation of this most important question, by the Royal Veterinary College, I think your Lordship will find that the valuable information afforded by Dr. Sticker's report is calculated to throw additional light upon the subject which will be brought under the consideration of the said Committee, and may consequently be of great assistance in solving the question at issue, and thus render considerable benefit to the agricultural interests of Great Britain.

"I further beg leave to inform your Lordship that Dr. Sticker has at the same time invented a new instrument for effecting the inoculations according to his system, and has expressed a desire that a specimen of the same should respectfully be presented to His Royal Highness Prince Albert, who takes so lively an interest in the solution of the important question to which Dr. Sticker has devoted his constant attention; and I beg leave to forward the same to your Lordship under a separate cover, respectfully leaving it for your Lordship to decide whether with propriety it can be presented to His Royal Highness.

"In conclusion, I may be allowed to state that this question has attracted the serious attention of the Prussian Government, these provinces having unfortunately been most severely visited by the disease; and, convinced of the efficacy of the system, the Government do all in their power to promote the inoculation as much as possible, and at present, when the disease breaks out amongst the cattle in a certain locality, the authorities of that district immediately cause all the cattle to be inoculated, as the only means of preventing the infection from spreading.

"I have, &c.

(Signed) "J. R. Curtis."

In addition to this communication to the Government, we are enabled to give an extract from a letter which we have just received from Mr. Curtis, dated Cologne, June 1, 1853, and which confirms the conclusions we had previously arrived at.

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* See 'Papers respecting Pleuro-pneumonia in Cattle, presented to the House of Lords by command of Her Majesty, April 4, 1853.'

"I have really seen," says Mr. Curtis, "such extraordinary effects follow inoculation, and have also seen scientific men of the highest standing who *opposed the system* for a long time become *complete converts* to inoculation, that I can no longer doubt, and consequently I am an advocate of the system.

"The Prussian Government, who, as you truly remark in your Report,* ordered the operations of M. de Saive to be discontinued last year, are also *amongst the converts*, and inoculation is encouraged by every means by the Government."

Besides the inquiries of Dr. Ulrich in Belgium, it appears from some reports with which we are just favoured by Mr. Hebeler, the Consul-General of Prussia, that Dr. Lüdersdorff of Berlin has also investigated the subject of cattle inoculation in the Cologne district. This step was rendered the more necessary from the ill success of Dr. De Saive's operations last year. Dr. Lüdersdorff concludes his Report by stating that, "although his observations are perhaps not fully conclusive, still they certainly speak more in favour of than against inoculation. They show that *the danger of this remedy* is in no proportion to the losses produced by the *natural* disease, and that consequently inoculation should be more generally adopted." A committee of the Agricultural Society of Ober-Bamein district also reported that "Dr. Willem's plan of operating can be so improved as to avoid the ill consequences at present attending it."

Prussia, we thus see, has been induced to follow in the wake of Holland, by adopting inoculation as a means to save her cattle from the ravages of Pleuro-pneumonia.

As yet we are without direct or official information from France, and, therefore, we must not anticipate the opinions of her Commissioners being in favour or otherwise of the practice by any speculations of our own. It is probable that their Report may come to hand in time for the particulars to be inserted in the present paper; and if so, they will be given, so as to render the subject as complete as it can be under existing circumstances. Failing this information for the present, we come next to the proceedings of Belgium herself.

The Commissioners here have spared no pains to arrive at the true value of the practice of inoculation, and their Report, which extends over 176 pages 8vo., is full of most interesting and valuable details. In the majority of cases their experience fully coincides with our own, a fact to which we allude, in order to show the impartiality of their proceedings, and which we regret to see has been called in question. It is unnecessary to select cases from their Report, or to follow the Commissioners through their scientific reasonings on the subject; and, therefore, we shall in this place content ourselves by giving the conclusions to which they have arrived.

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* Mr. Curtis here refers to our former Report. See Journal, vol. xiii. p. 376.

"From the preceding facts," says the Report, "the Commission concludes:—

"That inoculation with the liquid extracted from a hepatized lung, the result of exudative Pleuro-pneumonia, is not a certain preservative against the malady.

"That the phenomena succeeding inoculation may be produced several times in the same animal, which may or may not have been attacked with exudative Pleuro-pneumonia.

"That the two affections may exist together in the same individual, and that considerable derangements are manifested in the inoculated part, whilst the morbid action of the lungs progresses towards a fatal termination.

"As to the ascertaining whether inoculation really possesses a preservative power, and if so, in what proportion and for what length of time it imparts immunity to the animals subjected to it, these are questions which can only be solved by further experience.

"Read and approved at a meeting of the Commission. Present—

"M. VERHEZEN,		President.
BELLEFROID,	DEUTERLUIGNE,	Members.
GLUGE,	SAUVEUR,	
THEIS,	THIERNESSE,	
FALLOT,	Delegates from the Royal Academy of Medicine.	
MARINUS,		

"*Brussels, Feb.* 6, 1853."

Having now shown that the present position of the question of inoculation justifies our remark of *its usefulness* being as yet a disputed point, we shall proceed to a detail of our own experiments, and of the deductions drawn therefrom. Before doing this, however, we must observe that there is a statement in the Belgian Report, given on the authority of M. Willem's father, which deeply affects our credit, and which consequently requires a reply from us. Reserving, however, for the present any further allusion to this matter, we pass to the subject immediately requiring attention.

In the first place, we shall give a brief history of the progress and rate of mortality of Pleuro-pneumonia in the herd of cattle among which our experiments have been instituted; a step rendered the more necessary in consequence of the effects which have followed inoculation. Any means which are correctly used to effect a proper solution of the question of inoculation cannot fail to be of interest to the agriculturists and cattle proprietors of this country, and the more so because here, as elsewhere, no efficient method of cure of Pleuro-pneumonia has been discovered. Hence we may remark, that the Royal Agricultural Society is under peculiar obligations to those public-spirited individuals who have shown their willingness to give up their cattle for legitimate experiments. It is deeply to be regretted that, while all persons are so ready to reap the benefit, so few can be found to incur the risk of a scientific investigation. It is right, therefore, to call attention to the fact named by Mr. Pusey, in a note appended to the former Report, "that it was with the kind

assistance of Mr. E. Denison, M.P., and through the liberality of Mr. Paget, of Ruddington Grange, near Nottingham, that the Society was enabled to make arrangements for testing the efficacy of inoculation."

On our first visit to Ruddington, Mr. Paget kindly placed at our disposal any number of animals we might select for the experiment of inoculation; and this notwithstanding he was in full possession of our opinion as to the serious ill consequences which might attend the operation, as well as our doubts of its ultimately proving of any value as a prophylactic. From the history given, it appears that Pleuro-pneumonia, which had prevailed more or less in the neighbourhood of Nottingham since 1843, first showed itself in Mr. Paget's herd in August, 1849. The attack was very virulent, and between this time and Christmas of the following year it carried off no less than seventy animals. In 1851 thirty fell a sacrifice to the disease, and from January, 1852, to the end of November, when the experiments were commenced, thirty-two more animals were destroyed by it. We have thus a total loss of 132 animals from August, 1849, to November, 1852, inclusive; a period of little more than $3\frac{1}{4}$ years. From the changing state of the herd, the ratio of deaths to the number kept cannot now be ascertained, but it will be seen that the losses may be described as being ruinous in amount.

Mr. Paget milks upon the average sixty cows for the supply of the town of Nottingham; besides which, he buys in from time to time a number of animals to fatten, and also to supply the place of those which have been sacrificed to this and other diseases, so that he has from 90 to 100 head of cattle usually on his premises. It is necessary to state that the amount of loss is partly guarded against by feeding the animals liberally, and by having them killed as soon as they give the slightest indication of being affected with Pleuro-pneumonia,—experience having shown the inutility of medical treatment.

The rate of progress of the disease has not been uniform, as it appears that several weeks have passed without any cases, and then somewhat unexpectedly a fresh outbreak has taken place. These repeated attacks have not been traced to any satisfactory cause, but the more recent losses would seem to be connected with the sudden appearance of the affection known as Epizöötic Eczema among the cows, in August, 1852. This disease produced a great fall in the condition of the animals, thereby rendering them more susceptible to the general causes of Pleuro-pneumonia. For some time prior to this date not more than one milking-cow in a month was affected; but since then, occasionally, as many as two in a week have succumbed to the

disease. It is a somewhat singular circumstance, that for three months after the appearance of Pleuro-pneumonia in the summer of 1849, the disease was entirely confined to the cows inhabiting one particular shed, although a free communication exists between this shed and the others where the cattle are placed. It was thought that this circumstance depended somewhat on imperfect ventilation, and steps were taken to remedy this supposed defect; still, however, this shed has *throughout* yielded by far the larger number of cases. Very little preference has been shown by the disease for either the fatting or milking cows, but the more recently purchased animals have generally suffered the most.

It is a fact, worthy of a passing remark, that a bull which had been two years on the premises, was at the time of our visit in perfect health; and also that another bull, which had free access to the cows in the fatal years of 1849 and 50, completely resisted the influence of the contagion. Both these animals were in turn made to live in a shed which adjoins the one previously described as being remarkably unhealthy; besides which, cow after cow was attacked while being tied up in a stall immediately contiguous to that occupied alternately by the bulls. We may further observe that the causes of the fatality are by no means apparent; the animals are liberally fed, well attended to, and not over crowded into confined or ill-ventilated sheds. They are of the "short-horn" breed, and mostly of middle age.

Various measures have from time to time been adopted to arrest the progress of the disease, but the effects have not been marked with any decided benefit. We here close the history of the disease in Mr. Paget's establishment prior to the introduction of inoculation, the particulars of which we shall now proceed to describe.

On the 27th of November sixteen animals were selected for the operation; of these, twelve were inoculated on the under surface of the tail, near to its extremity, by *superficial* punctures, and four by *deep* punctures through the skin, after the manner of Dr. Willems. It is necessary, however, to add that these deep punctures were *cleanly made with a sharp lancet*, and not with a *bad-cutting* "*double-edged*" *scalpel*, such as we saw *forcibly* thrust through the skin, and twisted about in the wound by Dr. Willems. This fact led to our remarking, in the former Report, that "surgical and scientific principles did not rule in these operations" on the Continent; and it is essential to allude to the circumstance again, because of the results which attended on these our first experiments.

The material employed for the inoculation was the *serous fluid* pressed from a diseased lung, and of this two or three drops were placed in each wound. Care was taken to have this fluid as fresh

as possible, and also that it should not come from a lung "over diseased;" for which purpose we caused an animal to be killed in the early stage of Pleuro-pneumonia, so that no untoward result might arise from a neglect of these precautions. We were assisted in these operations by Mr. H. Pyatt, veterinary surgeon, Nottingham, who is consulted by Mr. Paget in all cases requiring medical care, and who took a deep interest in these experiments. Mr. Pyatt also kindly undertook to watch the progress of events, and report to us as occasion seemed to require.

It was decided to leave *fourteen* of the inoculated cows to mingle indiscriminately with the rest of the herd, but to remove *two* of them to an infirmary shed, into which diseased animals, as they were attacked, were taken, so as to expose them to the more direct influence of the contagion. This experiment was continued for several weeks, when it was discontinued, the animals during the time remaining unaffected.

With *two* exceptions the inoculation *failed to produce the slightest effect;* and in these two animals it was not until the *fifteenth* day of the operation that the wounds inflamed. In consequence of this failure we determined to *re*-inoculate the cows, which was accordingly done on December 13th. *Twelve* only out of the fourteen were however operated upon, *two* being left to see if the previous inoculation would still take; Dr. Willems, in his Memoir, having stated that *a month* sometimes elapses before any local effects are observed. No such phenomenon occurred in either of the cases, but, nevertheless, as one of these cows, after inoculation, was a little out of health for about a week, and both Mr. Paget and Mr. Pyatt thought this might possibly depend on the inoculation, it was determined not to repeat the operation upon her. This cow, up to the present time, June 1st, 1853, has continued well. This cannot but be considered as a decided instance of a *non*-inoculated animal resisting for months, equally with those which were inoculated, the contagious influence of Pleuro-pneumonia; for the continental authorities affirm, and in this we fully agree, that no constitutional effects can result from inoculation unless local morbid action is first produced. With regard to the other cow, she was subsequently *re*-inoculated, and lost her tail from the gangrenous inflammation which attended the operation.

On one of the two *original* cases successfully inoculated, as it is ordinarily described, the inflammation was succeeded by ulceration of the parts adjacent to the puncture. It was feared that the animal's tail would be lost; such however did not prove to be the case. Further particulars, both with reference to this last-named cow, and also the *re*-inoculations, will best be

learned by the following note received from Mr. Pyatt on December 17th:—

"On Monday last, December 13, I went to Ruddington, and, in accordance with your directions, I *re*-inoculated twelve of the cows. Not the slightest effect was produced by the former operation, except in two cases. In one, No. 19, I found the tail swollen and very sore, with a scab about the size of a shilling covering the place of inoculation. I have seen this cow daily since Monday, and, although she appears to be perfectly well in health, the tail is now much more inflamed, and the wound looking so badly, that I fear in a few days the tail will slough. The *re*-inoculations were made from a *highly diseased lung*, and it seems to me they will all take, as the tails are now a little swollen and very sore when pressed.

(Signed) "HENRY PYATT."

It will be seen from this letter that the fluid used for the *re*-inoculations was the product of a more advanced stage of Pleuro-pneumonia; to this and also to the deep punctures made by Mr. Pyatt, the marked inflammation that speedily followed, or the success of the inoculation as it is designated, is to be attributed. On the same day that these twelve animals were *re*-inoculated two others were operated on, and on December 19th two more. These latter two were inoculated with *sero-purulent* fluid obtained from the inoculated places of other cows, being what is technically called "*a first remove*." The animals bore the respective numbers of 10 and 21, these being the marks stamped upon their horns on purchase, and necessary to be made mention of for the purpose of identification.

On the 23rd of December we paid a second visit to Ruddington. The local effects of the operation, consisting of *ordinary inflammation, advancing with greater or less rapidity to suppuration*, were marked in all; but, comparatively speaking, they were slight in seven out of the twelve *original* cases. The two animals operated on the same day with the twelve, December 13th, presented a similar condition of the parts, as did also the *two inoculated by the first remove.*

We selected *seven* of the most satisfactory cases from out of the fourteen inoculated *direct* with fluid from the lung, to give trial to *re*-inoculation. *On four of these the re-inoculation produced morbid action equally as great as the original inoculation;* on the others it failed. This fact, which is one of the first importance, we shall have again to allude to, and therefore we refrain from commenting upon it in this place. Between the 23rd and the close of the month four more cows were inoculated by "*the first remove*," and it was observed that more speedy action followed this method than that of *direct* inoculation with the exuded serum of the lung.

During the month of December Pleuro-pneumonia continued

to show itself among the animals on the farm, and carried off no less than *seven* of them—six *non*-inoculated and one inoculated. The inoculated cow was, however, one of those which had been operated on by "*a first remove*," on December 19th—No. 21. She was observed to be ill on the *fifth* day succeeding the operation, and an examination showed her to be the subject of Pleuro-pneumonia. The disease advanced so rapidly that by the fourth day of her illness it was deemed prudent to have her destroyed. The autopsy confirmed the correctness of the diagnosis. Mr. Pyatt writes that the right lung weighed 30 lbs.

Presuming inoculation does give security, this case must not be ranked among the exceptions or failures, for there cannot be a doubt that the animal was affected with Pleuro-pneumonia, in its *incubative* stage, at the time she was inoculated. It should be noted, however, that the inoculation *took effect upon a diseased animal, and that its local action was in no way modified thereby;* facts totally at variance with the established laws of inoculation for diseases which are daily propagated in this manner. The question of inoculation proving abortive as a means of protection, because it was one of "a first remove," cannot be raised in this particular case, as it has been in others, from the facts connected with the time of the animal's illness. With regard to the point of non-protection from this manner of inoculation, we may remark that No. 10, operated upon the same day with No. 21, and likewise the four cows previously made mention of as being *also* inoculated by "a first remove," have now been several months on the premises without giving any evidence of disease. In this particular they agree with those inoculated directly from the lung; hence we may infer, that, if one is protective, so is the other. This point, however, will present itself for our examination again in the sequel of this Report.

From the fluid obtained from the lung of No. 21 it was arranged to inoculate more of the herd, and accordingly the animals occupying "Shed 14" were fixed on.

Mr. Pyatt, in his report of the experiment, says, "that the inoculation, which was done the same in all, on December 29th, produced *considerable effect on six of the animals, very little on four, and none on the remaining four*." Notwithstanding these variable results, the experiments upon the whole were deemed to be sufficiently satisfactory to warrant the continuance of inoculation, and Mr. Paget accordingly determined that such should be done. On January 12th he wrote to the following effect:—

"I am inclined to think that inoculation is protective, for we have had in the fifteen hovel two cases of Pleuro-pneumonia out of three *non-inoculated* animals, while the remaining twelve, all of which had been inoculated, have

escaped, with one exception. This exception is No. 21, which received the virus from another cow's tail. I think it will be best to inoculate several newly-purchased animals, for it is something to have protection, even if it be but temporary."

(Signed) CHARLES PAGET."

The inoculations were continued from this period to the end of February, with slight interruptions, by which time *all the animals, amounting to about one hundred, were inoculated.*

The extension of the inoculation was accompanied by a marked reduction in the number of the cases of Pleuro-pneumonia. During January three animals died of the disease, two of these being *un*-inoculated; the other inoculated, but only on the day preceding her illness. For practical deductions this animal must be viewed as a *non*-inoculated one. In the month of February four cows sank from Pleuro-pneumonia; two of these had been inoculated and two not. In March a year-old bull died. This case will be presently explained. April passed without a death, but May has furnished us with three deaths, and all in *inoculated* animals.* As in by far the larger number of these cases the local effects differed but little from those which have already been described, it is unnecessary to enter into the details, but a summary of the whole is required.

The inoculations, with the exception of the six "first removes" previously described, were all made with the serous exudation of a diseased lung. In the major number of instances the inoculation *took the first time*, that is, slight effusive inflammation succeeded by suppuration followed the operation; other animals required *a second*, and a few *a third inoculation* to produce these effects.

Five cows *completely resisted the inoculation*, having been operated on many times at various intervals, without the slightest effect.

In *one* case no evidence of the inoculation was observed for a month; and it is worthy of observation that thrice during this time this animal was out of health, and required medical treatment; at the end of the month the tail became inflamed, and swelled to the size of a man's arm. The inflammation ended in ulceration and sloughing of the skin, but the organ was saved. This case is also the more remarkable, as, in all other instances where the inflammation has run high, the action has *quickly* followed the operation.

* A letter received this morning, June 1st, from Mr. Paget, states that "another cow, making the third, has been killed, having the complaint without doubt. She was of the second batch of inoculated subjects." At the close of his communication Mr. Paget says, "I hope, however, you will feel justified in recommending further trials of inoculation, for I cannot doubt that I have derived great benefit from its use."

Eight cows lost their tails from mortification, induced by the operation. Evidence of this untoward result was generally afforded about eight or ten days subsequent to the inoculation.

One animal, the young bull previously mentioned, died from the inoculation. The mortification which succeeded extended upwards, affecting the perineum, rectum, and adjacent parts. His death occurred on the twenty-first day of the operation. The lungs and viscera of the chest were found free from disease.

This freedom from disease of the lungs will be hereafter commented on; it is referred to by the Dutch Commissioners, who, also, in another of their conclusions have truly observed that "when the violent action occurs, and extends to the more vital parts, affecting the whole system, its progress can as little be prevented and checked as the disease in general can be cured."

The two inoculated cows which were lost in February by Pleuro-pneumonia were attacked the one three weeks and three days and the other three weeks and five days subsequent to inoculation. The effects of the operation are described as being slight.

The three cows which were attacked in May with Pleuro-pneumonia were inoculated, one on January 13th, another on the 20th, and the third on the 21st of the same month. The latter two were both observed to be ill on May 5th, being fifteen weeks after the inoculation. The third cow, inoculated on January 13th, was taken ill on May 22nd, and disposed of two days afterwards, being eighteen weeks and three days subsequent to her inoculation. In two of the animals Mr. Pyatt reports that the effects of the inoculation were *comparatively* slight, but yet deemed at the time to be sufficient to protect them.

We now proceed to some experiments which were made in the Royal Veterinary College on animals also furnished for that purpose by Mr. Paget. On our first visit to Ruddington in November it was arranged to send six cows to London; the animals accordingly were forwarded by rail, and arrived safely at the College on December 10th.

Four days afterwards, it being considered that they had recovered from the fatigue of their journey, we inoculated three of them in the usual place and *somewhat* in the usual manner, *cautiously making the punctures just through the skin* of the tail. *No effects followed*, and the inoculation was therefore repeated in the same careful manner, at an interval of eight days, that is, on December 22nd. This inoculation *also failed*, and, instead of having recourse forthwith to deeper punctures "*roughly made with a bad-cutting instrument*," we determined to try *punctures*, punctures even still more superficially made, and also scratches of the cuticle. This was done on *all the cows* on December 30th;

as many as a dozen *superficial* punctures clustered together on the *labia* or *perineum*, or more distant placed *on the tail*, were made with a grooved needle; in each case the material used being, as before, the serous fluid from a diseased lung. As we had anticipated, this method failed in every case.

It is necessary here to state that one of the cows, which, from the date of her admission, three weeks before, was suspected to have the disease Pleuro-pneumonia incubated in her system, from her peculiar cough and other symptoms, fell ill on the day but one succeeding this inoculation. The animal bore up under the depressing and destructive influences of the disease in its active form for the somewhat lengthy period of twelve days, when death put an end to her sufferings. The post-mortem appearances agreed in every particular with those seen in similar cases.

Jan. 6th, 1853.—The five cows were again inoculated in a manner somewhat modified from the former. The skin of the *perineum* was scratched with a lancet, sufficiently deep to cause a very slight oozing of the blood from the numerous erasions, and then upon these places a portion of *diseased lung*, *well charged with serous and fibrinous effusions*, *was rubbed* for the space of two or three minutes. The cases were most assiduously watched, so that the slightest indication of the action of the fluid, if specific, would have been observed, but nothing took place even from this plan of operating.

14*th*.—We determined to give trial once more to simple erasions of the cuticle, and to-day inoculated the five cows belonging to Mr. Paget, together with another cow admitted into the infirmary for mammitis, and also a heifer under our care for lameness. Groups of erasions, varying in number from twelve to twenty, were made on the *labia*, *perineum*, and under surface of the tail in each animal, and upon these the serous exudation *was rubbed with the finger* for not less than from four to five minutes. No specific effects followed.

20*th*.—Inoculated each of three of the cows again, which had been chiefly the subjects of the foregoing experiments, with two *deep* punctures made with a *grooved needle*, and the two others with four *superficial* punctures, all of which, like the preceding inoculations, also proved abortive.

It appears pretty certain from these experiments that slight punctures, and also scratches of the skin, will invariably fail; a fact which of itself is almost sufficient to disprove the existence of any "special virus" being contained in the exudations from an affected lung. Every person of experience in these matters knows full well that success of inoculation, both with regard to the *local* and *constitutional* declaration of the symptoms, depends on the *smallness* of the quantity of the virus employed, and the

minuteness of the puncture by which it is introduced into the system.

The virus of Pleuro-pneumonia, if the exuded fluid may be so called, would not, in our opinion, as an animal poison, be an exception to the law which governs the extension and reproduction of such poisons. It was clearly ascertained with regard to the small-pox of sheep, at the time of its great prevalence, that inoculations which were made by deep punctures and the introduction of three or four *ordinary* drops of the virus, destroyed many scores of these animals before the pock could be developed on the skin. Success here depended, as in all other cases, on the rules which we have described as applicable to the puncture and to the inoculating material. With inoculations for the prevention of *natural* Pleuro-pneumonia the very reverse obtains; success is connected with deep wounds and the employment of three or four ordinary drops of fluid. To return, however, to the experiments; for these things will again present themselves for our investigation.

28th.—Inoculated three of the cows by making an *incision through the skin*, just below the labia of each, and inserting into the wounds a small quantity of serous exudation from a diseased lung, using for the purpose a little friction with the point of the scalpel.

Feb. 1st.—A slight tumefaction exists around the wound in one case. The lips of the other incisions are thickened, but otherwise free from swelling.

2nd.—A small pustule has formed by the side of the incision which was yesterday tumefied; but the adjacent skin is free from *undue* redness. Scabs exist on the other wounds, which are now swollen and approaching to suppuration.

3rd.—Suppuration is established in all the cases. The tumefaction around the incisions is very slight, and the redness *scarcely* perceptible.

To-day we *re*-inoculated *these same cows*, by making *clean* incisions through the skin about half an inch long and about three inches below the others, into which was inserted with the point of the scalpel a little of the *purulent* fluid taken from the original inoculated places.

4th.—The pus discharged from the *original* wounds is of a good colour, and the general condition of the parts does not indicate any interference with the healing process being quickly accomplished.

5th.—The swelling around the *second-made* incisions is more than we have before seen. The parts are sore when pressed, and it is evident that the wounds will quickly suppurate.

7th.—Pus is being discharged from the wounds; it is white,

but thin. The swelling of the surrounding parts is augmented, but unaccompanied with increased redness.

Incisions were to-day made by the side of the labia in the same three cows, and in like manner a little pus from the *second-made* wounds was inserted.

8*th.*—The *second-made* wounds are less swelled, and have a more healthy appearance. It will be unnecessary to allude to their condition again.

10*th.*—The *third* inoculated wounds are inflamed. The swelling and soreness are quite equal with that of the *second* at the same distance of time from the inoculation.

12*th.*—The wounds have a more unhealthy condition than any of the preceding. The lips are gaping, and the purulent discharge is thin and discoloured.

14*th.*—Slight ulceration is going on.

18*th.*—The incisions are more healthy, and time alone is required to effect their healing; they will therefore not again be reported.

Still making these three cows the subjects of experiment, we determined in the next place to inoculate them again with *fluid from the lung and deep incisions;* this was done, *and in each case the wounds comported themselves as before.*

The *sero-purulent* discharge was taken as early as possible from these "*lung-inoculated*" places and used on *other cows*, in a like manner as it had been in the former experiments on the animals themselves: a similar result attended this procedure. Two sheep were also inoculated with the same purulent fluid at the same time, and the wounds in these animals inflamed and suppurated as in the cows.

We shall now return to the two cows of which no mention has been made since January 20th, when they were for the last time *un*successfully inoculated by superficially puncturing the skin. On February 1st these animals were inoculated by a deep and roughly made puncture, after the plan we had witnessed in Belgium. At the end of a few days their tails were swollen and tender on the application of pressure. The inflammation increased, and by the eighth day of inoculation pus was being discharged from the incisions. A small ulcer formed near to the place of inoculation in one case, and delayed the healing process. In the other case no such event occurred. By the 16th the wounds were cicatrizing.

These being what are described as successful inoculations, we were anxious to inoculate these animals again in the same manner, to ascertain their capability of taking a second time. This was done. In one cow the effects were as marked as before, in the other the inoculation failed.

The animals were next inoculated with purulent fluid taken from an inoculated sore, the incision being made on one side of the *labia*, while on the other side a similar incision, charged with an *irritating medicinal agent*, was also made, that the effects might be contrasted. The wound in which the pus was placed became inflamed the soonest and to the greatest extent, but so slight was the difference between them, that no person ignorant of the operation would have noted it, or any other peculiarity.

The operation was next modified by using in one wound the medicinal agent and in the other *serous exudation.* The order of the phenomena was now reversed,—that is, the wound containing the irritating agent inflamed the soonest and to the greatest extent; otherwise no difference was to be detected.

The final experiment on these animals consisted of inoculating them again with *serum and roughly made punctures;* this *perfectly* succeeded, thus showing that their susceptibility to the local action of the morbific fluid exuded from the lungs was in no way destroyed by the former inoculations.

Some few experiments have been instituted on other animals, to which we will now briefly allude:—

Feb. 7th.—Two sheep, a donkey, and a dog were inoculated with serous fluid, and at the same time a heifer which had been three days *previously* inoculated with *sero-purulent* matter obtained from an incision on one of the cows.

9th.—The wounds are inflamed in the dog and the sheep, but not in the donkey or heifer.

10th.—Inflammation increased in dog and sheep; incision in heifer slightly inflamed; no effect in donkey.

12th.—Incisions suppurating in dog and sheep; inflammation increased in heifer; a little swelling in the donkey.

It is sufficient to add, that after this date the inoculated place in the heifer suppurated, the action seemingly in no way being controlled by the *previous* inoculation. In short, the two wounds comported themselves precisely as erasions of the skin would have done, received on different days by some slight accident.

The incisions in the dog and sheep healed readily, as did that of the donkey—the latter without the production of pus.

Subsequently two other sheep, two pigs, and a second donkey were inoculated in the ordinary manner. In each case inflammation, succeeded by suppuration, supervened. The sheep and pigs were inoculated on the inner side of the thigh, while on the opposite thigh in each animal a *simple* incision of equal dimensions, viz. about three-fourths of an inch in length, was made with a *clean scalpel* for the sake of comparison. These simple wounds healed readily in all the animals, and without suppuration, except in one instance where a little pus was formed.

Before stating the conclusions to which we have come, with regard to inoculation being resorted to as a means to arrest the progress of Pleuro-pneumonia, we will offer a few observations on some points contained in this Report.

It will be seen, that, although the casualties in Mr. Paget's herd at Ruddington amount to the loss of the tails of eight cows and the death of a young bull, they still are short of those on the Continent. We find it recorded in the report of Dr. Ulrich, that out of fifty-one animals inoculated in July of last year, in an establishment where the disease existed, no less than thirty lost their tails, and four were killed by the operation. Four of the number also died subsequently from pleuro-pneumonia; and to show that the inoculation had taken effect on these animals, it is remarked that each of them had lost its tail.

The information obtained, however, in Belgium, and embodied in our former report, showed that the average deaths from inoculation were estimated at 2 per cent., and loss of tails at about 12.

The improvement which we have experienced in this country doubtless depends, somewhat, on the inoculations being made in the winter months, during which time the exudations from the lung undergo slower decomposition, when exposed to the air, than when a higher temperature prevails, as in the summer. It is also attributable partly to the manner of performing the operation, because, although we have been constrained to make deep and comparatively rough punctures, still we have used good lancets, instead of bad-cutting double-edged scalpels, the counterpart of a scratching knife, found on one's writing-table, and have also refrained from twisting the instrument about in the wound. That the extension of the inflammation to the upper part of the tail and adjacent parts, in so many of the continental operations, depended on these causes we cannot doubt.

The cases seen at the Brussels school on the fifteenth day of inoculation, where greater care had been exercised, showed the tails of the animals entirely free from swelling and the incisions nearly healed; while many cows at Hasselt, at a far later period, had their tails so engorged by inflammatory effusions as to lead to the necessity of making incisions some 4 or 5 inches long to relieve the distended tissues.

Fortunately, such casualties as these are not of very frequent occurrence; nevertheless they show how dangerous a proceeding it is to introduce, into the living organism of an animal, a fluid which, as a product of disease, has been eliminated from the vessels of another animal of the *same species*. These inoculations in truth very closely simulate wounds received in the dissecting room.

It is an established fact that animal matter, thus accidentally conveyed in dissection from man to man, is incomparably more

dangerous than it would be if introduced into the system of any ordinary animal. The reverse of this is likewise equally true. Thus many a medical student, who perchance may bid fair to occupy an exalted position in his profession, has fallen a sacrifice to a trivial wound received in the dissection of a diseased body, while the veterinary student, on the contrary, from having to dissect our ordinary domesticated animals, rarely suffers from such wounds. This law offers an impediment to, but does not entirely prevent, the conveying of a disease, from animal to animal of a different kind, by inoculation. We have a good example in sheep not being susceptible to the action of the *small-pox virus of man*, although remarkably so to that of their *own small-pox*, and also of man being susceptible to the virus *of his small-pox*, but *not* to that of sheep.

With reference to the decrease in the number of cases of Pleuro-pneumonia at Ruddington since the adoption of inoculation, we would observe that great caution should be exercised in coming to an opinion of the cause of the decline of an epizoötic, or even an ordinary contagious affection. Circumstances about which we know but little will cause the outbreak of an epizoötic disease, and circumstances about which we probably know less will produce its removal. There are periods in the history of Pleuro-pneumonia on Mr. Paget's premises, when the cattle have been for weeks as free from disease as since they were inoculated. The time, we admit, is longer, but the cause may be the same

It was acknowledged, even in Hasselt, that they had had as little disease in some summers, prior to the employment of inoculation, as during the last when the system had reached its climax. In proof that inoculation was not the sole cause of this freedom, is the fact that the cattle of the distillers who objected to have the operation performed continued as healthy as those of others who did not so object. What we contend for is, that, as there are no specific *local* effects produced by inoculation, so *protection* does not depend on the special action of a special virus on the organism, as is the case with the vaccine and other similar diseases.

Protection we believe to be more apparent than real, and that it results mainly from *simple* local irritation. When this and the accompanying inflammation are slight, the animal is in constant danger of an attack of Pleuro-pneumonia, even whilst the local action exists: when greater, a simple issue is produced, the effects of which, as a drain on the system, are more lasting and therefore likely to be more beneficial; but when carried to the fullest extent, then the animal's life is endangered from another cause, namely, from the sphacelitic action which ensues. With regard to the utility of simple issues or setons, it

is well known that if these are employed, care being taken *to prevent their weakening effect* on the constitution by the exhibition of *tonic medicine*, or the use even of a nutritious diet, not only Pleuro-pneumonia but many other diseases will be sometimes prevented.

Further, with regard to protection, we must call attention to the present amount of loss in Mr. Paget's herd. The inoculations were begun at the end of November, and with irregular intervals carried on so as to be completed by the beginning of February. Now, dating from the end of November to the end of May, when we have the last report of the health of the animals, it will be seen, by reference to the particulars contained in this report, that during these six months no less than *five inoculated* animals have died of Pleuro-pneumonia after inoculation. This on the year, at the same ratio, would give 10 per cent.—a number equal to the annual average loss of M. Willems sen., and to guard against which he adopted inoculation.* It must likewise not be forgotten that in many instances on the Continent, the disease, instead of decreasing, *has progressed much more rapidly after inoculation than before*, affecting indiscriminately the inoculated and the *non*-inoculated animals. A fact of this kind was to be expected with a contagious disease like Pleuro-pneumonia, when inoculation was roughly done *on animals already of weak constitution* and perhaps badly kept, as thereby their susceptibility would be further increased to the influence of the contagion.

To proceed to other matters. It is stated in the fifth conclusion of the Dutch Commission, and admitted by all observers, that the lungs are not *specially* diseased from an inoculation, although death may result therefrom. To the arguments advanced in our former report on this head, we may add that the *non*-production of Pleuro-pneumonia by inoculating an animal with the serous exudation from a diseased lung, must be admitted as one good proof among many others that such exudation is not a special "virus." If the exuded serous fluid produced *a special and well-marked inflammatory action locally*, prior to generating a peculiar condition of the constitution, although the evidences of the latter might be so slight as to be hardly recognized, as is the case with the vaccine lymph; or if it caused sooner or later the disease Pleuro-pneumonia itself, *altogether independent of such local inflammation*, of which we have an example in Rabies, then there would be no difficulty in admitting that the inoculation of cattle was founded on scientific principles. Neither of these properties has, however, as yet been satisfactorily proved to belong to the

* See First Report, Journal, vol. xiii. p. 376.

fluid, and therefore we are content to remain among those who do not advocate the system. As a product of a *specific disease*, conveyed from animal to animal *of the same species*, it should produce *that disease*, upon the principle that "like begets like."

It is a property of an animal virus, and common to them all, to multiply to an unascertainable extent within the circulating fluids or blood, when introduced into the organism by inoculation, and subsequently to centre in some especial part of the body. Usually this part is either directly external, or it has a free communication with the outlets of the body, apparently for the discharge of the morbific matter from the system. We observe these things especially to belong to the virus of small-pox, which is, however, but *a type of the class.*

The skin in small-pox becomes the focus of the disease after the multiplication of the poison has been effected. Every vesicle placed on the skin contains the virus; it therefore partakes of the same nature, and is capable in the same manner of further extension as was the original vesicle. The inoculated disease is thus proved to be identical with the natural; it is accompanied with the same symptoms, constitutional and local, and is alike capable of indefinite extension both by infection and contagion. How entirely opposed to these laws is the inoculation of cattle for the prevention of *natural* Pleuro-pneumonia. According to Dr. Willems and other advocates of the system, the virus, when introduced, affects the blood; augments within it; causes both local and constitutional disturbance; is reproduced in the areolar tissue of the tail at considerable distance from the site of its insertion; is capable of being transmitted from animal to animal; gives immunity against an attack of Pleuro-pneumonia — thus far agreeing fully with the phenomena of *genuine* inoculation;—*and yet it never produces the disease, although it not unfrequently destroys the animal even weeks after its employment.*

The pillar on which inoculation stands is that of a disease being capable of transmission from one animal to another by the application of a special cause. Remove this, and it falls. The giving of immunity, or destroying the susceptibility to second attacks of the disease, are but as the ornaments of the capital, adding to its beauty and its value, but not to the necessity of its existence.

Fortunately, however, for the ends of science, inoculation, or the operation of the special virus of a disease on the body, is so far beneficial, that nature, having freed herself of the materials existing in the organism which are capable of being converted into the same description of virus as that which had been employed in the process, is not again susceptible, as a rule, to a

second action of the morbific matter. In small-pox and other diseases of the class, we trace this immunity to the production of the malady by artificial means, and this production to an augmentation of its *special* virus within the organism.

The *protection* afforded by *vaccination* to an individual against small-pox stands upon a foundation equally secure with that of inoculation. "The vaccine disease" is in reality the small-pox of the cow. By the process which has been named *vaccination* the small-pox of the cow is transmitted to man, and fortunately with incalculable benefit, because, while the disease possesses the *same nature*, it wants the *malignancy* of human small-pox.

The experiments we have herein recorded prove that some of the animals were susceptible to the action of the serous exudations of the diseased lung, not only *a second but a third time*, *or oftener*. These cases are too numerous to be viewed simply as exceptions, for in our first experiments, out of *seven* selected animals, *selected because of the success of the inoculation*, no less than *four* were immediately acted on by a second inoculation. Nor do we stand alone in proving these facts; the Belgian Commissioners, as we have previously remarked, state "that the phenomena succeeding inoculation may be produced several times in the same animal;" and they add, what is of equal importance, "which may or may not have been attacked with exudative Pleuro-pneumonia."

We admit that the period of immunity afforded by inoculation as a general principle does vary in different diseases, and also in the same disease in different animals. What, we ask, is the proof of this immunity being lost? Why, the susceptibility of the animal to a *re*-inoculation. If this should fail, the animal was secure; if succeed, the animal was unprotected. Among the cows we have alluded to were some which had been inoculated only three weeks before, and in others the effects of the first operation were still manifest at the time of the *successful re-inoculation*. In our experiments also, when we succeeded in producing effects which would give perfect satisfaction to the advocates of the system, by inoculation with *the serous fluid*, we have taken the product of this inoculation and used it forthwith on the *self-same* animal as well as *on others*, and obtained results equally as great as from the original inoculation. How could these things be explained were we dealing with a specific virus?

We have called this product *sero-purulent* fluid, and so in reality it is when first exuded from the wound, but it presently becomes altogether and entirely pus. Our experience therefore confirms that which we had anticipated with regard to these inoculations *by removes*, namely, that the effect would be both more certain and speedy, because *pus* was the material employed.

Removes, therefore, cannot be effected on true or scientific principles. We have no *materies morbi* to be modified and improved by being passed through the systems of *healthy* animals in succession, as is the case with the *primary* virus of a small-pox vesicle.

The occasional incubation of the so-called "pulmonic virus," after its introduction into the wound, of which fact we have recorded some notable instances, has been advanced as an argument in favour of its specific nature, and it has been said to agree in this particular with the poison of rabies. To this we reply, that when the rabid virus does come into operation, no matter how remote the period may be, it produces that dreadful disease (rabies), but that when this supposed virus of Pleuro-pneumonia begins to act it produces only local inflammation and ulceration. The cause of the serous fluid remaining now and then inert for three or four weeks may be somewhat difficult to explain; but no more so than that of two animals receiving an injury at the self-same time by which some foreign agent enters the body, and the one being quickly affected with local inflammation in consequence, the other not being affected perhaps for some weeks. All pathologists are familiar with facts of this description.

As to "Jennerian principles" being the foundation of these inoculations of cattle, as has been stated by Dr. De Saive and others, we hesitate not to say, that, whatever else may belong to them, no principle expounded by Jenner will be of the number. By vaccination, which, as we have shown, is essentially inoculation, Jenner either prevented the small-pox or mitigated its severity when it did occur. Pleuro-pneumonia, on the contrary, when occurring in an inoculated animal, is in no way lessened either in its severity or fatality by the inoculation of that animal with the so-called special virus of this disease. On this point there seems to be no diversity of opinion. Belgian, Prussian, Dutch, and English investigators agree here. We say nothing of France, as the report of her Commission has not yet reached us.

We now come to a question to which allusion has previously been made as affecting our credit, and which we find published in the Belgian Report. It appears that two cows belonging to M. Willems sen. were attacked with Pleuro-pneumonia subsequent to their inoculation, and that one died and the other was killed, as her recovery was past hope. The *onus* of this casualty would seem to have been intentionally thrown upon us, as we are said, by M. Willems sen., *to have inoculated these animals when in Hasselt and to have used for the purpose improper material.* It will, however, before making any comments on this statement, be better to quote at length the particulars as published in the Report.

Under the heading of 'FAITS CONTESTÉS,' p. 174 *et seq.*, the Commissioners, quoting the minutes of the proceedings at Hasselt, say, "On the 2nd of December MM. J. Nolens and T. Vaes proceed to open a beast, aged five years, belonging to M. Willems. The chest contains an abundant sero-sanguineous effusion in which float albuminous flakes; the left lung, adhering to the costal pleura, is hepatized at its anterior portion." MM. Nolens and Vaes add, "The particulars that we have gathered from *MM. Willems, father and son*, are that *this beast was inoculated during September last by one of the two English veterinary surgeons** who came to examine their cattle, and who wished to see the application of the process; that it was inoculated with virus taken from the tail of another inoculated beast; and lastly, that the operation had *no results.* A portion of the lung, and the end of the tail, upon which *two large cicatrices* may be perceived, are contained in the jar No. 19."

"On the 16th December MM. Vaes and Maris, delegates for that purpose, went to the knacker's yard in order to make an autopsy of another beast belonging to M. Willems. The animal, which was inoculated on September 1st, bears the mark of *a successful operation.* It presented the first symptoms of exudative Pleuro-pneumonia on December 4th.

"On the 11th M. Vaes was requested by the proprietor to treat it. The treatment was continued till the 15th, when it was decided that the animal, being unfit for consumption, should be killed and buried. The chest contained a large quantity of fluid, the right lung was adhering to the costal and diaphragmatic pleura, was entirely hepatized and of enormous size. A part of the lung and the end of the tail are preserved under the cover No. 25.

"We read in the minutes of the proceedings," add the Commissioners, "that *M. Willems declared to the veterinary surgeon, M. Vaes*, that this beast was *successfully* operated on *by the same English veterinary professor who inoculated the one which was killed in consequence of Pleuro-pneumonia* on December 2nd, and with virus taken from the tail of another beast."

"Dr. Willems explains how it was that these animals were not protected. 'Two beasts,' says he, 'inoculated *as an experiment, with pus* (not lymph†) taken from an incision made in the tail of

* It is necessary to explain that I was accompanied in my visit to Belgium by my friend and colleague Professor Morton, who was desirous of going to the Continent for his summer's vacation. He never on any occasion interfered with my investigation, it being a thing entirely foreign to his avocations as a chemist and his taste as a man of science.

† It may be necessary to explain that the term *lymph* is used by the medical profession to express the specific contents of a vesicle, such as that produced in vaccination. It is held by many to be synonymous with *virus*, and is employed in that sense in this place by Dr. Willems, who, however, speaks almost invariably of the "*special virus*" of Pleuro-pneumonia.

an animal previously inoculated, in the presence of Professors Simonds and Morton, who made a note of it, have contracted the disease; they were placed among the other cattle in the stable. Two days after the insertion of *the virulent matter* the small wounds were suppurating.'

"We here insert the declaration of M. Willems' father, which we refrained from inserting in the minutes of the Hasselt Commission at p. 145. This distiller informs us, and *begs us to make mention of it in the present Report*, that some cases of failure which the delegates of our Commission have been enabled to prove in two animals coming from his stables, furnish him with a new proof of the system of inoculation adopted by his son. 'These two beasts,' says M. Willems, 'were operated on by the Professor of the Royal Veterinary College of London, *with matter resembling pus, taken from another inoculated beast, which he considered improper*. The phenomena of inoculation succeeded quickly upon the operation, and went through the various stages in eight days.'"

The Commissioners further observe that, "in our sincere desire to arrive without prejudice at the discovery of the truth, we have contented ourselves with the simple statement of facts, refraining entirely from discussing them. We have said, at the beginning of this Report, that *all the uncertain cases have been passed by in silence, or have been presented with a character of doubt attached to them.* We also give M. Willems full credit —1, for reporting, even to the minutest circumstance, all facts which have appeared favourable to inoculation; 2, for placing under the head of '*Faits contestés*' everything which the physician of Hasselt assumes has resulted from an improper operation, *and also the two cases which occurred in his father's stables.* Having made all these concessions, we have still *fifty-five* animals in which inoculation has failed to prevent the invasion of exudative Pleuro-pneumonia. The facts observed at Niony Maisières, a focus of the epizoötic, are of great importance."*

We will first observe, with regard to this accusation, that rumours of it had reached us some weeks since, which, however, we refrained from taking any notice of at that time, not believing it possible that any person would have had the temerity to publish such an incorrect version of the facts of the case. Without multiplication of words we will at once say, and we challenge proof being produced to the contrary, that we neither *suggested* the experiment, *selected* the material, nor *performed* the operation. That two cows were inoculated on the 1st of September, with some *viscid serum* obtained from deep incisions made in the tail

* The italics in the foregoing extract are our own.

of a cow, to relieve the inflammation which resulted from her previous inoculation, and that we were present and made notes of these cases, is perfectly true. These inoculations were *the very first* we witnessed, and were done *by Dr. Willems to show us the method of operating.* This fact is of itself almost sufficient to negative the statement of MM. Willems, father and son, "that one of the English professors inoculated the animals." The son here named we understand not to be Dr. Willems, but his brother, because, as will be observed, the Doctor gives a different version of the affair. How has it happened, that such a great discrepancy as that which exists in the statements of the MM. Willems and Dr. Willems, crept into the Report, if the simple truth had only to be told?

Besides this there are various other discrepancies in the narrative which are irreconcilable. We have the statement of the Doctor that in two days from the inoculation "the small wounds *were suppurating* in both animals;" while M. Willems sen. says, in the first beast which died there were *no effects produced;* and the delegates of the Commission assert there were "*two large cicatrices on the tail*"—which they preserve, together with a portion of the lung, to prove, *firstly*, that the animal had been inoculated, and, *secondly*, that it died with Pleuro-pneumonia. "Two large *cicatrices*," and no result from the inoculation:—how can this be explained? We, from our intimate knowledge of this particular case, can say that *an ulcer formed by the side of the place of inoculation, and produced the second cicatrix.*

To pass to the other case. The inference which Dr. Willems wishes to be drawn from the speedy suppuration of the small wounds is that the beasts were not protected because *not specific* but *common action* resulted from "*the virulent matter—the pus*"—which was employed; in other words, the inoculation was unsuccessful. Opposed to this, *first* comes the statement of MM. Vaes and Maris, that the animal bears the mark of a *successful* operation; *and then* the declaration of M. Willems sen., "that this beast was *successfully operated* on by the same English veterinary professor who inoculated the animal that was killed in consequence of Pleuro-pneumonia." The Doctor virtually says that both the animals were unprotected; that neither was successfully operated on. The father says "that *one* of them was successfully inoculated, but the material used on *both* was bad;" and the delegates write, "*two large cicatrices exist on the tail of one of the animals, and the other bears the mark of a successful inoculation.*"

If Dr. Willems knew, in September last, that these cows were unprotected, how comes it that they were left in a focus of the disease under such circumstances for three months daily exposed

to danger? Instead of such contradictory statements, we should have wished to have seen the Doctor nobly taking his stand and saying,—These cases are the only exceptions, in my *own* operations, to the rule which I have proved in hundreds of instances to belong to inoculation as preventive of Pleuro-pneumonia:—as exceptions, they show how great is the value of my discovery. And in truth we will now say, for ourselves, that if this system of inoculation be built on a foundation equally secure with that of inoculation or vaccination for small-pox, not ten times the number of failures which have occurred in M. Willems' establishment will lessen our opinion of its value. It must be remembered, however, that Dr. Willems originally took his stand on the untenable ground, that inoculation properly performed *never would fail* to give immunity to the animal against Pleuro-pneumonia.

We turn now to the assertion that the animals were "inoculated, as an experiment, with *pus* (*not lymph*)," an assertion by-the-bye equally correct with that of our having inoculated the animals.

Dr. Willems says we made a note of the case; this we have admitted to be strictly true; and fortunately we have that note still standing in our memorandum-book. It runs as follows:—

"*Sept.* 1, 1852.—Saw two cows with deep incisions in their tails, situated far above the place of inoculation, and freely discharging a *glairy albuminous or serous fluid.* Dr. Willems called this "*bon virus.*" He took some, secured it between two pieces of glass, and gave it me. He also inoculated two cows with it to show me the manner of operating."

Thus we see that when these cows were inoculated it was "*bon virus*," so good that we were presented with some of it, to bring home for use on the cattle of England; but when one of these self-same cows (for it is not said that both of them were inoculated on September 1st, and therefore possibly not with the same material) contracted the disease of Pleuro-pneumonia, then it was "*virulent matter*," "*pus* (*not lymph*)." We have more notes in our memorandum-book, and will produce one, as possibly it may refer to the other cow mentioned in the foregoing extract as being "inoculated during September last."

"*Sept.* 9.—Saw two cows at Willems sen.'s, with gangrene of their tails, or rather of the stumps, their tails having been amputated high up. They were inoculated with serous fluid expressed from a diseased lung. *The fluid is said not to have been good, but yet twenty more cows were inoculated* with the same material. These cows are reported to have done well. Doubtless one of these animals will die; the superior part of the stump, labia, and adjacent parts are gangrenous. A portion of gangrenous skin was sliced off by Dr. Willems, who said, with emphasis, in answer to my question, that the virus it contained was *très-bon.* When asked again if it was not charged with gangrenous materials, '*Non, non,*' was the reply. . . . . I considered this skin such a treasure that I begged a bit of it, and carefully packed it up in the MM. Willems' presence."

In taking leave of this question we wish again to record our regret that we should have been compelled to give particulars *in extenso* which we had carefully avoided even the mention of in our first Report. Justice, however, to the Society which we had the honour to represent in this investigation, and justice to ourselves, required that the full yet simple truth should be declared.

Elsewhere we have pointed out the danger which is connected with the introduction of diseased exudations or products into the organism of a healthy animal. In proportion to the extent and duration of a malady, so will these exudations become more vitiated, as well as changed by their retention within the body, by the operation of chemical laws, and the danger of the proceeding will be correspondingly increased. Some of the continental experimenters, and among them Dr. Lüdersdorff, have said that *no effects* will follow the employment of the serous fluid which is effused into the areolar tissue of the lung at the commencement of Pleuro-pneumonia. They add that in an advanced stage of the disease the effusion is almost certain to produce its action, and that at the termination of the malady not only does it never fail to act, but that it often produces the death of the inoculated animal from the mortification which ensues. These phenomena are just those which medical men know to belong to dying, dead, and decomposing animal matters in these different conditions, giving us another proof thereby that no special virus exists in the exudations of a diseased lung. It must be remembered that in small-pox, to which we have so frequently alluded as the best example of a specific disease, *the virus* is equally present in the *first* as in the *last* exudations.

As we have not to discuss the utility of other prophylactic measures besides inoculation in Pleuro-pneumonia, we end this Report by giving *seriatim* the conclusions deduced from our investigations and experiments :—

1. That inoculations made by superficial punctures and simple erasions of the skin invariably fail to produce any local inflammatory action, being the reverse of the case with regard to the vaccine disease, small-pox, and other specific affections, of which it is an indication of success.

2. That the employment of *fresh* serous fluid, and a cleanly made but *small* incision, during the continuance of a low temperature, will also almost always fail to produce even the slightest amount of inflammation.

3. That deep punctures are followed by the ordinary phenomena *only* of such wounds, when containing some slightly irritating agent.

4. That with a high temperature, roughly made incisions, and serous fluid a few days old, local ulceration and gangrene, pro-

ducing occasionally the death of the patient, will follow inoculation.

5. That the *sero-purulent matter*, taken from an inoculated sore, causes more speedy action than the *serum* obtained from a diseased lung, and that "*removes*" cannot be effected on scientific principles.

6. That oxen are not only susceptible to the action of *a second* but of *repeated inoculations* with the *serous exudation* of a diseased lung.

7. That an animal inoculated with the serous exudation is *in no way protected even from the repeated action* of the sero-purulent fluid which is produced in the wound as a result of the operation.

8. That animals not naturally the subjects of Pleuro-pneumonia, such as donkeys, dogs, &c., are susceptible to the local action both of the serous exudation from the lung and the sero-purulent matter obtained from the inoculated wounds.

9. That the serous fluid exuded from the lungs is not a specific "virus," or "lymph," as it is sometimes designated.

10. That inoculations made with medicinal irritating agents will be followed by similar phenomena to those observed in inoculations with the exuded serum.

11. That inoculation often acts as a simple issue, and that the security which at times the operation apparently affords depends in part upon this, but principally on the unknown causes which regulate the outbreak, spread, and cessation of epidemic diseases.

12. That inoculation of cattle, as advocated and practised by Dr. Willems and others, is not founded on any known basis of science or ascertained law, with regard to the propagation of those diseases commonly called specific.

13. That pleuro-pneumonia occurs at various periods of time, after a so-called successful inoculation.

14. And lastly, that the severity of Pleuro-pneumonia is in no way mitigated by previous inoculation, the disease proving equally rapid in its progress and fatal in its consequences in an inoculated as in an *un*-inoculated animal.

James Beart Simonds.

June 1, 1853.

XX.—*On the Farming of East Lothian.* By CHARLES STEVENSON.

To the President.

DEAR SIR,—IN offering this Report, your request to compile one on the farming of the Lothians must be my apology. Had the state of your health, when you were in Scotland in September last, permitted you to have continued the inspection of the farming in the Lothians, you would unquestionably have compiled, as the result of your own observation and intercourse with the farmers, a Report much more interesting to English readers than the one now presented, by seizing upon those points, whether of contrast or resemblance, which characterise the farming of the Lothians as compared with that of districts in England somewhat similar as regards soil and climate, and thus presenting in a more prominent light what might be partially or wholly adopted by the English farmer. Minuteness of detail, however, lies more within the range of one who is familiar with the farming of a district; and as the success of any mode of cultivation depends in no small degree upon such details, a more minute account of the farming of East Lothian will enable those desirous of adopting any part of the systems of cultivation there practised to do so without much difficulty.

The three Lothians, East, Mid, and West, taken together, do not contain a greater superficial area than a moderately-sized English county. They, however, present varied geological and climatic features which have so decidedly influenced the character of the systems of cultivation adopted as to require that the farming of each county be considered separately. For the present, therefore, we will confine the Report to the farming of East Lothian.

This county being one of those selected for the statistical experiment instituted by government, facilities are thereby afforded for entering more closely into details. The first of these returns was presented to Parliament last session. It embraces the area of arable and pasture lands, of wood and waste. The extent under each kind of crop, and the numbers of the domesticated animals within the county at the date of the return (20th May, 1853), are also given. The number of threshing-machines with the nature of the motive power is appended. The second Report, which is now (December 3rd) given to the public, contains the estimated acreable produce of the different districts. (For both see Appendix.) We will make use of the first of these returns so far as available in illustrating the systems of cultivation practised. From the additional information furnished in this

Report, the public will be enabled, by combining and comparing with it the statistical returns, to understand more fully the peculiar features of the systems of cultivation practised in East Lothian.

The county of East Lothian, more correctly termed Haddingtonshire, is defined by natural boundaries, that side excepted where it joins Mid-Lothian. The Frith of Forth forms the Northern; the German Ocean the Eastern; and the range of the Lammermuir Hills the Southern boundary. The Lammermuirs, from abutting partly into the county of Berwick and partly into the county of East Lothian, form a portion of the area of both, the smallest portion being embraced in the latter county. The extreme length of East Lothian is about 20 miles, the extreme breadth 15 miles, average breadth under 10. The superficial area is estimated at 150,000 acres.

The surface of the county presents a curious geological feature in a series of ridges, ranging from west to east. In most instances these, which are commonly a succession of gentle undulations, run parallel to one another, rising higher as they recede from the Forth and approach the Lammermuirs. Those portions of the Lammermuirs which are under cultivation are generally very steep. In the lower parts of the county, where the trap-rock approaches or comes to the surface, the land is usually uneven, frequently with abrupt ascents and descents. In some instances the trap formation assumes a conical form; in others that of an abrupt crag. On many farms, partly or wholly of this formation, the surface is broken and rocky. Considerable portions are thus waste. Limestone rocks are found in many districts. At the close of the last and the beginning of the present century, lime was, however, frequently and in large quantities applied to the soils which did not contain it naturally.

The nature of the rock formation influences but does not determine the character of the soil resting upon it. That character is partly determined by the constituent elements of those rocks which go to the formation of the groups of hills to the west, mostly situated in Mid-Lothian, and partly to those which bound the county towards the south. The closer the district is to these influencing causes, the composition of the soil is usually less in keeping with that of the rock upon which it rests. The boulder clay also goes to form the constituent elements of a very considerable portion of the soils in the county. In some districts this clay forms both the soil and the subsoil. Where the formation is either red sandstone or trap, the soil is usually in unison with the composition of the rock, partly intermixed with the boulder clay. These rocks are generally only thinly covered with soil. They appear to have been partially denuded by an

Oceanic sweep from the west, flowing to the east, and depositing the débris to the east of all protruding rocks or hills. The predominating feature in most soils is clay, more or less retentive. Where light, sandy, or gravelly soils prevail, they are generally situated along the coast, the margins of some rivers, or more properly "burns," or at the foot of the Lammermuir hills. The character of the surface soil in most instances has been partially altered by the application of lime and manures. This alteration is most marked along the coast-line, where the refuse of towns or fishing villages and sea-weed, which have been long applied to the land, and lime, have changed the original texture of the soils, what were primarily sandy or clayey soils being now rich light or heavy loams. These soils, from this acquired composition, and from the local facilities as regards supplies of sea-weed, have long maintained a high character for productiveness. This circumstance has so influenced public opinion as to attach a character of *natural* fertility to the county which it does not possess. The large crops raised in East Lothian are attributable *mainly* to the liberal application of manure and a judicious system of cultivation, aided by a somewhat favourable climate.

This statement is not applicable to East Lothian alone. The principal corn-producing districts in England, such as Lincolnshire, Norfolk, and Suffolk, all consist chiefly of soils naturally inferior. The same remark holds good across the Channel, of which Belgium is the most striking example. If we glance at ancient countries, Palestine and Sicily, at one time great corn-producing and even exporting countries, they also have soils naturally inferior.

The prevailing soils in East Lothian are clays, more or less retentive. These soils, when chemically examined, show a higher percentage of argillaceous matter than their appearance would indicate. As there exists considerable misapprehension on this point we will state briefly the causes which are in operation tending to mislead practical and even scientific men. The character of a soil, viewed agriculturally as regards friability or retentiveness, is less dependent on the composition of the soil than on the nature of the climate—the quantity of rain which falls—the manner in which it falls—the nature of the subsoil, whether retentive or porous—the nature of the rock, whether compact or intersected with fissures—the average amount of obscuration of the sun's rays—the character of the wind as regards the amount of moisture—the force of its currents; in short, it is the relation subsisting between the air and the soil, which, within certain limits, renders a soil either friable or retentive; and, we may add, highly fertile or comparatively barren. An ordinary clay soil may, from the character of the climate, be

either a friable loamy clay or a stiff retentive clay. Thus, a friable loamy clay in East Lothian would be with a corresponding retentive subsoil a stiff retentive clay in the West of Scotland. Besides, thorough-draining has tended to alter the character of the soil of this county more than of any other the writer is acquainted with. The freeing of the land from superfluous moisture by this means has doubtless raised the temperature of the soil, and may to a slight extent have diminished the percentage of moisture contained in the atmosphere—thus improving the climate. From the absence of correct observations previous to and during the period in which the drainage has been accomplished, this alteration cannot be definitely determined. But that a change has taken place may be inferred from the fact that the sowing of wheat in spring, which, within less than twenty years, was seldom deemed prudent except along the coast or upon the driest gravelly soils more inland, is now found upon almost all soils to answer nearly as well as in autumn, under the same circumstances as to condition of soil. Spring-sown wheat in favourable seasons is indeed often even more prolific than autumn-sown, especially upon lands in very high condition.

As regards climate, the situation of East Lothian is highly favourable, being situated on the eastern side of the island, and partially sheltered from the force of western winds, which always carry less or more moisture along with them. This moisture, when in the form of clouds, is partially arrested by the high grounds to the west. The Lammermuir hills also form a partial protection from south-western gales. The effect of this range of hills, however, is to give a greater force to those currents which pass across the island, especially when from the west. These hills, with the high grounds on the Fife coast, contract the currents of air and make them sweep along both the low grounds of the county and the Frith with increased force. When the winds blow from the east or north-east, which they generally do during the spring months, they rapidly free the soil from superfluous moisture. These winds are generally cold, and consequently act prejudicially both upon animal and vegetable life. Inflammatory complaints, especially of the organs of the chest, are thus often superinduced. When the south-eastern currents of air are surcharged with moisture, deluging falls of rain occasionally take place. When these occur during harvest they interfere seriously with the saving of the crop; when they occur during the period of turnip-sowing, sowing is retarded or partially prevented for that season, particularly on retentive soils. The currents of air, especially from the west, sometimes assume the force of a gale, or even a tempest. In the early spring months, or towards the middle and end of September, they occasionally

blow with great fury. When they occur during harvest, serious injury is often sustained from the shedding of grain. On exposed situations the loss from this cause alone, during the currency of a lease of nineteen years, has been estimated on some farms at three rents, and has not unfrequently so hampered the occupant as to prevent him from fulfilling the terms of his contract.

The climate of East Lothian is favourably influenced by the proximity of a great body of water—the German Ocean on the east, and the estuary of the Forth on the north. During winter the temperature is thus raised, which operates favourably on the feeding of stock, particularly of sheep folded on turnips, and cattle kept in open courts. During summer there is frequently a sea and land breeze during the twenty-four hours: this generally commences in June, and continues through the summer. The quantity of rain which falls in different districts within the county varies considerably. On the south-western side the quantity which falls some months in spring is double that which falls in the lower and eastern districts. This difference is most marked in June and July. During these two months the absence of sufficient moisture not unfrequently injures both cereal and root crops, occasionally reducing the produce by one-fifth, or even one-third, below that of a more favourable year. The fall of rain for the last six years in the parish of Dirleton is as follows:—

1847	22·1
1848	28·7
1849	22·2
1850	17·7
1851	18·2
1852	26·2
Average . .	22·5

In the following description of the rotations practised in East Lothian we will first give the details of the different systems of management, and also subjoin an account of one or two farms, which will better illustrate our general remarks.

There are three rotations, which embrace nearly all the farming of the county—a four, a five, and a six course shift.

The four-course is—

1. Turnips, potatoes.
2. Wheat, barley.
3. Grass-seeds, depastured or cut.
4. Oats.

The five-course is—

1. Fallow, turnips, potatoes.
2. Wheat, barley, oats.

3. Grass-seeds, depastured.
4. Grass-seeds, depastured second year.
5. Oats.

The six-course is—

1. Fallow, turnips.
2. Wheat, barley.
3. Grass-seeds, depastured or cut.
4. Oats, barley.
5. Beans, potatoes, vetches.
6. Wheat.

Sometimes the last is made an eight-course shift by repeating five and six, the fifth and sixth, the bean or potato and wheat crops; changing, however, the portions under the bean and potato respectively.

The four-course shift was at one time much followed. The desire to grow turnips on lands suitable for them induced farmers to adopt this course on all dry portions of their farms; the remainder being cultivated on the six-course shift, commencing with a plain fallow. On some farms, however, the four-course shift was exclusively followed, from the land being dry enough for the growth of the turnip. Since the introduction of thorough-draining this rotation is yearly going into desuetude. During the period when the four-course shift was more in repute it was found that the turnip, and also the clover, from being grown at such short intervals, became less healthy and vigorous. To overcome this in regard to the turnip the five-course shift was introduced. At one time it was in considerable favour, it being argued that, on a farm cultivated on the five-course shift, as much grain and as much weight of root crops could be produced, and at a diminished cost for labour, while in addition the profit of a second year's pasture was obtained. It was found, however, that the growth of the clover plants became even more precarious under the five than under the four course. This rotation is now deemed suitable only for deep rich loams, although it is still followed on a considerable portion of the upper districts and on inferior soils, these being deemed less suitable for the bean and potato. It is, like the four-course shift, being gradually abandoned, as thorough-draining and a more correct apprehension of the principles which should regulate rotations become more general. Besides, it is now found that to grow more corn and roots with the aid of guano, rather than allow the land to be in pasture, is the more profitable. In the six-course shift the potato has taken the place of the bean on soils suitable for its growth. On some farms the potato and the bean alternate in the rotation, each being thus grown only once in twelve years. The present comparative immunity of this

county from the potato blight has stimulated its cultivation, and at present the profits are so much beyond what has ever been obtained in the cultivation of any other crop that the breadth cultivated will doubtless go on rapidly increasing, even should the present price of potatoes recede a half. The desire to extend the breadth under this root will tend partially to alter existing rotations.

The great proportion of the clay soils is now thorough-drained, still a portion is undrained, or very imperfectly drained. Where undrained, a plain summer fallow usually commences the rotation; where drained, the turnip: the imperfectly drained portions are dependent for the raising of turnips on the condition of the land as regards root-weeds, and still more on the nature of the season in the spring months. Previous to the introduction of thorough draining, a plain fallow was deemed the foundation of all good husbandry in the cultivation of retentive soils. Since then, however, the freeing of the land from superfluous moisture has so changed the character of these soils, that not unfrequently they are found to be better adapted for the growth of the turnip, especially the swede, than what were originally deemed turnip soils.

When land is to be plain fallowed, ploughing is usually delayed till winter or spring. On very retentive soils it is found that, when ploughed in spring (February or beginning of March), it works more kindly during summer—the roots of the weeds being more easily extracted. In the end of May or the beginning of June, a second furrow, generally across, is given, followed by harrowing, grubbing, rolling, and harrowing, to bring the weeds to the surface. These being collected, a third furrow is given; after the weeds are gathered a second time, the land is ploughed into ridges, the old furrows being as far as possible adhered to. This ploughing is generally performed in July or beginning of August. After farm-yard manure is applied, the land is ploughed with an ordinary furrow. Sometimes another furrow is given previous to sowing, with the view of incorporating the dung more thoroughly with the soil, and also of destroying any annual weeds which may have sprung up. Where farm-yard manure is not applied, rape-dust at the rate of 5 to 10 cwt., or guano at the rate of 2 to 4 cwt., is given previous to sowing the wheat. In upland districts sowing is preferred in the end of September; in the middle districts, the second week of October; in the lower districts, some farmers have found the largest produce from spring sowing.

The management of the land intended for turnip is as follows:—Where swedes are to be grown, it is generally deemed advisable to apply farm-yard manure to the land previous to autumn ploughing. The quantity applied is from 10 to 16 cart-loads of manure, each cart-load weighing from 14 to 18 cwt. This, after

being carefully spread, is ploughed in, a furrow from 8 to 12 inches being the ordinary depth. Some prefer ploughing across, some along the ridge. The former is becoming yearly more general, it being found that the land is in better condition in spring, and consequently involving less labour. Some farmers, dispensing altogether with spring ploughing, make use only of the grubber in preparing the land previous to sowing. On some stiff retentive clays, or very light friable soils, even this is found injurious. The usual practice, however, still is to give two furrows in spring, sometimes across the ridge, each furrow being followed by harrowing, grubbing, rolling, and collecting of root-weeds. Where the land has a tendency to be cloddy the roller is used. Of these Crosskill's is most esteemed where the clods are very large and hard; but Cambridge's, or the smooth cast-metal roller, makes a finer surface for obtaining a haird.

As the weight of the root-crop is greatly dependent upon the period at which it is sown, it becomes necessary to study whatever will facilitate progress. It is found that, on a farm where five pairs of horses are kept, the following arrangement is the most conducive to expedition, the field being previously reduced to a proper tilth:—Three ploughs are employed to drill, 3 horses in single carts to apply the manure, and 1 horse in the turnip-barrow to sow the seed. The manure is generally stored at the end of the field: when not in the field, two or more horses are required for carting to keep the ploughs going. In commencing the sowing of the field, the side farthest from the gate is selected. After from 12 to 16 drills 28 inches apart are formed, a cart with manure passes down, the manure is drawn out, the cart still going on, into little heaps, sufficient for manuring three drills. As one cart is emptied another is ready to take its place, a boy being employed to drive the cart to and from the manure-heap. Female labourers follow to spread the manure, 6 being the number required to keep the three ploughs busily going. The portable manures are sown by another labourer, either male or female. As soon as the manure is spread, the ploughs pass down the drills, cleaving the former drills to cover in the manures. Thus, in passing up, the ploughs form drills in which the manure is deposited, and, in passing down, reform the drills, covering in the manure. The turnip-barrow, which sows 2 drills, follows, thus completing the operation. The breadth completed in $9\frac{1}{2}$ hours is 4 or 5 acres—on very friable soils even more.

If farmyard manure has been applied in autumn, portable manures alone are applied in spring. An allowance of from 2 to 4 cwt. of guano, or 1 to 2 quarters of ground or dissolved bones, is given. Guano has, however, almost superseded bones or arpe-dust. When farmyard manure is alone applied in spring,

which is now rarely done, from 12 to 16 tons of well-rotted dung are given; but it is usual to supplement this quantity with some one or other of the portable manures. All the turnips in East Lothian, and indeed in Scotland, are sown upon the ridge, the usual breadth of the drill being 28 inches. The sowing of the swedes commences generally about the 10th of May, and continues up till the end of May or first week of June. As soon as the sowing of the swedes is completed, that of the other varieties, yellow and white, follows. Of the yellows, the Purple Top and the Green Top are held in about equal estimation. Of the white varieties, the Globe is the most esteemed. The proportion of swedes to the other varieties is in ordinary seasons fully one-third—the swedes on soils adapted for them being always preferred.

The weight of the turnip crop is no less dependent upon the manner in which the plants are singled, and the land stirred after singling, than upon the preparation of the land. The swede variety is usually ready for singling in about six weeks after sowing; the other varieties sometimes in four weeks. They are either singled by the hand or by the hoe—very generally, however, by the hoe—3 persons overtaking an acre in the day in ordinarily favourable circumstances. The distance between the plants varies from 9 to 15 inches—the latter is considered more advantageous than the former where the land is in very high condition.

Previous to thinning, a drill-grubber is generally passed between the rows for the purpose of destroying as many of the weeds as possible. After the plants recover the singling, which operation is generally done when the plants are at a very *early* stage of growth, they are again grubbed; sometimes a single-horse paring-plough takes away the edge of the drill: hoeing is again performed; and, after another grubbing, the cleaning is completed. Some farmers use a plough for slightly earthing up the drills; the propriety of this, however, is questionable, especially where the land is thorough-drained.

In consuming the turnip, some farmers remove the whole of the crop off the ground, commencing with the white variety. The more general system is to remove the greater portion, the rest being eaten on the ground by sheep, the proportion removed varying from one-half to three-fourths. This depends upon the breadth grown, the quantity of straw the farm produces, and the proportion of other feeding stuffs which are used along with the turnip. The folding of sheep sometimes commences on stiff soils in the beginning of September. The storing of the white variety for cattle generally commences by the end of October,

going on through November. In November and December a portion of the yellows and swedes is also stored. Previous to removal from the field the roots and tops are cut off, and, in doing this, the person so drops the roots as to allow the passage of a cart for their removal. To clear a field speedily, a number of single carts, according to the distance they have to be carted, are yoked. Female labourers are usually employed to fill the carts, men and boys driving them. The roots are stored generally in oblong pits, about 6 feet at the base, tapering to a top. A covering of straw is put over them : sometimes this is secured by ropes, especially if windy and frosty weather is expected. The removing of the crop from the field for being consumed by cattle goes on during the winter and spring whenever the weather admits of it. It is always considered advisable, however, to have the land *cleared* by the middle of March. It is found that turnips are more nutritious if they are allowed to remain in the ground and not long stored ; the white varieties suffering most from storing, the swedes least.

Of the swede several varieties are grown. The Green Top was introduced, about 1785, from Gottenburg, being the first swede grown in Scotland, and first raised on the farm of Lawhead, East Lothian. It is a somewhat curious circumstance that, when the swede was first cultivated in this country, the seed was sown in beds, and the young plants removed to the fields, the transplanting being similar to what is done with cabbages. At first, this variety was esteemed more for the tops than the roots, they having been generally allowed to remain in the ground till they came partially into flower, and given to stock just previous to the grass season. The Purple Top was selected from this variety, and is by many preferred to the Green Top. Several other varieties have been introduced into the county ; Laing's, Fettercairn's, both almost now unknown, having proved very inferior varieties ; Skirving's, and a still more esteemed variety, obtained from Suffolk about 10 years ago, Curwen's. Of yellows, the first grown in the county, and introduced shortly after the swede, was propagated by Mr. Carnegie of the Hailes, being a hybrid between the original swede and the White Globe. Dale's hybrid, once much esteemed, is now seldom grown. Aberdeen and Skirving's Purple Top Yellow are the present favourites, along with the original variety. Of the whites, the Globe is the most generally grown. A Green Top variety obtained from England some years ago is also esteemed. Another Green Top variety, tankard-shaped, was introduced about six years ago from Herefordshire. Owing to the nature of the climate, the whites require to be stored before Christmas, except where they are not full grown ; frosts being liable to injure their feeding qualities.

It is, however, very rarely that frosts injure the more hardy varieties.

After the removal of the turnip crop, preparatory to wheat sowing, a furrow of medium depth, 4 to 6 inches, is given—the land being sometimes gathered up into ridges, more commonly, however, ploughed flat in the ordinary manner of four ridges, with an open furrow every 24 yards. If the condition of the land admits of it, sowing frequently follows the ploughing; some, however, prefer allowing the land to lie for a time previous to sowing. As much as possible of the turnip-land is seeded before the middle of December, as sowing is generally suspended from that period till February. Spring sowing commences sometimes towards the close of January, but the end of February or beginning of March is preferred. A red variety for "April wheat" is sown sometimes even to the end of April. This variety occupies the ground about the same period as the later varieties of barley. In favourable seasons nearly the whole of the turnip break is sown with wheat; but since 1847 the relative prices of barley and wheat have changed, so that many farmers now prefer a crop of barley to spring-wheat, the acreable money return being not unfrequently in favour of the barley. Last season, from the difficulty of getting in the usual breadth of wheat, barley has a higher place in the statistics of the county than it would otherwise have had, although its cultivation is extending.

The varieties of wheat most grown are Hunter's, Fenton, and Hopetoun of white wheats, and Lammas red, Spalding's, and Nottingham of reds. Of the whites, Hunter's occupies the largest breadth, Fenton the second, and Hopetoun the third. Considerable diversity of opinion exists as to which of them is the best. Fenton, being a stiff-strawed wheat, admits of more liberal top-dressings, and its acreable produce, especially by the application of guano and the nitrate of soda, can thus be greatly increased. Its cultivation is from this cause greatly extending. Hunter's has been an established variety for about sixty years—Hopetoun and Fenton about fifteen. Besides these, which may be termed local varieties, there have been several introduced from the south. These are generally found, however, to deteriorate so much in a year or two, that they speedily lose favour, and considerable losses have been sustained from growing new varieties.

Some farmers apply from 2 to 3 cwt. of guano to the turnip-land previous to sowing the wheat. Some apply farm-yard manure, but guano is the most general application, top-dressing with it in spring being now the most esteemed practice.

If sowing is delayed till March, the grass-seeds are sown at the same time as the wheat. If Autumn sown, these seeds are put in generally in March. The quantity of seed varies considerably;

some allowing less than 2 pecks, others 4 of rye grass. The allowance of clover is generally 8 to 10 lbs. of red, 3 lbs. of white, and in addition sometimes 3 lbs. of yellow. Others prefer a larger quantity of clover, especially when the land is intended to be depastured with sheep. After the removal of the cereal crop from the ground, the young seeds are depastured with sheep up till the middle of November or beginning of December. In spring if sheep stock, frequently ewes and lambs, are to be fed on the grasses, they are put into the field as they drop their lambs; but the field is seldom full stocked till the end of April, or even later. The cows belonging to the master and servants are put to grass about the middle of May, and, if the cart-horses are depastured, generally about the end of May. Little of the grass is cut for hay. Where the horses are soiled with a few cattle in the courts, a field is set apart, generally convenient to the steading, for cutting. But as a rule, the grass-seeds are depastured, sometimes with cattle, but more generally with sheep stock.

In spring the stones are sometimes collected even on fields intended to be depastured, but always on those intended for cutting. In some districts of the county the number of stones upon the surface is very considerable, although diminishing by this collecting.

By December the ploughing of lea commences on the one-year, and sometimes on the two-years pasture. One field is occasionally reserved until spring for the accommodation of the ewe stock. Scarcely any of the lea is ever sown with wheat, it being found, after many trials, that the oat crop almost always realises more money than lea wheat, besides leaving the land in better condition as regards cleanliness. When sown at all it is now found that spring-sown wheat is the most certain. But as we previously stated, oats are almost universally taken after lea.

Of the oat, several varieties are grown. The potato variety is grown upon all friable and rich soils. On the colder clays the late and early Angus are grown. Other varieties have been from time to time introduced, but they generally lose favour. The black Tartarian has been grown for some years, and stands high for prolificness, particularly on soft soils.

It is now found that guano, at the rate of 2 to 4 cwt., can almost always be profitably applied to the oat crop, *however high in condition the land may be.* The practice is extending, and promises to become all but universal.

If the land is cultivated on the four or five course, the rotation terminates with the oat crop; if on the six-course, beans or potatoes follow the oat crop. When land is intended for beans it is generally ploughed early in autumn; the farm-yard

manure being applied either previous to ploughing or in the drill previous to sowing. On all soils, even on the best, it is always found advantageous to apply farm-yard manure to the bean crop. Some give, in addition, guano in the drills previous to sowing. The drilling of beans with the manuring is managed much in the same manner as the turnip, the drills being formed 28 inches apart, the manure deposited in the drills, and the seed sown above the manure with a bean-barrow, which covers three drills at a time. It is generally found advantageous to have a proportion of peas mixed along with the beans: the proportion varies; the richer the soil, the fewer peas are sown.

The variety generally grown is the common Scotch bean. Some years ago the tick bean was introduced, but it has not gained much footing.

If the land is intended for potatoes, a deep furrow is given in autumn, and farm-yard manure almost always applied, at the rate of 12 to 20 cart-loads an acre. As soon as the condition of the land admits of it, in spring, the land is grubbed or ploughed previous to planting, which is performed as early in the season as possible, it having been ascertained that the effects of the blight are less virulent on early planted potatoes. If farm-yard manure is applied in spring the quantity is usually limited, from an impression that it has a tendency to increase the blight. Guano is all but universally applied, sometimes at the rate of 4 cwt. per acre. The drills are formed in the same manner as for turnips, and the sets are deposited about a foot separate, each set generally containing only one eye.

Previous to the appearance of the bean or potato the drills are harrowed down with light harrows. This destroys the growth of annual weeds, and assists in the braiding of the crop. As soon as either the beans or potatoes are hoed a grubber passes between the rows, and, after hand-hoeing, another turn of the grubber is generally given. Beans are generally hoed the second time; potatoes always. After the second hoeing the potatoes are moulded up.

The bean crop is usually ready for cutting in September; potatoes are generally ready for lifting at the same time, but, from the press of harvest-work, lifting is mostly delayed till October. After either of these crops is removed the land is ploughed for wheat—sowing immediately following.

Beans are considered the best preparation for wheat; but the *quality* of the wheat after potatoes is always superior. Only one furrow is given previous to sowing. Sometimes the bean land is grubbed and the weeds collected; but even this is now generally dispensed with. Upon the bean and potato break

some farmers apply from 2 to 3 cwt. of guano for the wheat; others again prefer giving 8 to 10 cart-loads of farm-yard manure. Many, however, give no manure in this part of the rotation, though top-dressing the wheat after potatoes almost invariably pays well.

The statistical returns show other crops cultivated in the county, but these do not constitute a part of the ordinary rotations. We will shortly notice these.

Vetches (the extent of which last season was 1011 acres) are not much grown, the breadth on most farms being only a few acres, to be cut green for soiling. They generally occupy a part of the bean break, and are sown early in spring; the land, after the crop is cut, being cleaned preparatory to wheat. Sometimes oats are grown along with them, to prevent them rotting on the ground, the Scotch tare growing more luxuriantly than any other known variety. Folding sheep on tares is not much practised in this county, and is indeed almost unknown in Scotland.

Mangold, of which there were only 48 acres, is less cultivated now than it was some years ago. It is, however, again coming more into favour as a substitute in part for the swede. The principal objection to its extended cultivation appears to be the great liability of the plant to run to seed. The variations of temperature, with occasional droughts, seem to us the explanation of this peculiarity connected with the mangold in East Lothian.

Carrots, of which there were 107 acres, are grown only for sale. They are cultivated on light sandy soils near the coast. The variety generally grown is the Altringham. Edinburgh is the principal market; part being sold for table use, and part for horses.

The cultivation of flax is now abandoned. At one time each hind and cotter was allowed to grow a small breadth (1-16th of an acre); it was, however, commuted into the same breadth of potatoes. About three years ago, when the cultivation of flax was so strongly recommended, several farmers made trials of it. The result was, that it was found to be upon the whole less remunerative than the ordinary cereals.

Turnip-seed, of which there were 49 acres this season, is grown principally for sale; the Swedish varieties occupying the greatest breadth. The seed of selected bulbs is sown some time in the end of June or the beginning of July. In some instances, however, when the bulbs of an ordinary crop are not deemed of sufficient value for feeding purposes, they are allowed to remain for seed.

Cabbages, of which there were 15 acres, are also grown partly for sale and partly for feeding.

Rye, of which there were 46 acres, is only cultivated on light sands along the coast.

Improved permanent grass extends to 6228 acres. This is principally in parks and pleasure-grounds in connection with proprietors' seats. *Fields allowed to lie in permanent pasture form no part of the agriculture of the county.* Sometimes a small field is kept in grass near the farm-house, partly for convenience and partly for amenity.

There are 9313 acres under woods: these are generally in connection with gentlemen's residences, and are not primarily intended for shelter, although of course they contribute to improve the climate of some of the districts. Hedge-row timber and trees scattered throughout the fields are all but unknown. Perhaps on no other point is the Scottish farmer more sensitive than on the loss which generally accrues from trees on cultivated land.

The number of acres under irrigated meadows is 87; but the principles which should regulate irrigation are so little understood in the county that the practice is not extending, although the climate, and in some instances the situation, are favourable for its adoption.

Under sheep-walks there are 28,630 acres. The Cheviot breed occupies these almost exclusively. The Leicester, or crosses with the Leicester, encroach somewhat upon them, and the black-faced breed is not yet wholly displaced; at the beginning of the present century the black-faced all but exclusively occupied the Lammermuirs. The Southdown has been attempted to be introduced, but it was found that the lambs did not stand the severity of the spring so well as the Cheviot.

Returning again to what is more strictly arable husbandry, we proceed to give details as to management.

The quantity of seed per acre is regulated in part by the variety grown, the condition of the soil as regards richness, natural texture, friableness, altitude, the period of sowing, and the manner in which the seed is deposited, whether drill or broad-cast. The usual practice is to allow too much seed. This arises partly from custom, and partly from the destruction caused by crows and game. With high condition and freeness of the land from weeds, the improved practice is to allow less seed. In the case of the turnip, 2 to 4 lbs., varying according to the fineness of the tilth. Wheat after turnip, if autumn-sown, from 10 to 12 pecks; if spring-sown, from 12 to 14. Barley from 10 to 12 pecks if sown in March; 1 or 2 pecks less if sown in April. Oats vary considerably, 8 to 12 pecks on soils in high condition, but the most common quantity is from 12 to 16 pecks. Beans vary from 9 to 13 pecks, the latter being most common. Wheat after beans from 9 to 13 pecks. Wheat is usually prepared previous to sowing by being steeped in a

solution of sulphate of copper, 1 lb. to 2 lbs. being dissolved in water for the quarter of wheat.

The farm implements differ essentially in character from those in general use in England—simpleness of construction and cheapness being deemed the desiderata by a Scotch farmer. The plough and harrows are of iron. The form of the plough and mould-board is nearly identical with those in use in the English border counties. Swing ploughs are the only form in use. Some experiments have been and are being made with Ransome's, Busby's, and Howard's ploughs. The most contradictory reports are given as to the success of these.

The rollers are generally smooth, Crosskill's and Cambridge's being the only exceptions. As the patents do not extend to Scotland, they are furnished at a cheaper rate than they are in England. The common rollers are made of stone and iron, the last being more esteemed. When of cast metal, they are in two lengths, and are made either for one or two horses, the weight of the metal determining the weight of the roller. The diameter of the roller is generally from 20 to 24 inches. The end-frames are usually of cast metal; the two longitudinal bars, as well as the shafts, are of wood, and are formed nearly in the same manner as the shafts of the common cart. When two horses are yoked, the one is in shafts, the other in trace.

The grubbers are Kirkwood's and Tennant's; the latter, from its greater efficiency and cheapness, is destined to supersede the former. They are drawn by two horses, and accomplish about 5 acres per day. In preparing land for root-crops, the grubbers are found to be invaluable implements, diminishing the amount of horse-labour, and reducing the land to a finer tilth, besides lessening the tendency to become foul from couch.

The sowing machines are all simple in construction. The *turnip-barrow* is made to sow two drills. They are somewhat varied in shape, but are all upon the same principle.

The drills are of very simple construction. The lever drill, introduced about fifteen years ago by Mr. Slight, appears to be considered the best.

The drill-hoes are on the same principle as Garrett's, being somewhat simpler in construction, and cheaper, but perhaps equal in efficiency. A broad-cast sowing machine, used for cereals and grass-seeds, is coming into general use. They are constructed to sow ridges 18 feet in breadth, but capable of being adjusted to sow a less breadth. They are light of draught, being drawn by one horse. The saving of seed alone in one season generally covers the original cost. Besides, the seed is more equally distributed than it can be by hand.

Reaping machines, introduced in 1852, were in that season

all on Hussey's principle. The number introduced that year was very considerable. They proved all but complete failures. As most of the farmers who were induced to order them had stipulated for an efficient reaping machine, most of those sent were thrown on the hands of the makers. This season, 1853, several of Bell's reaper were obtained, manufactured by Crosskill. These proved upon the whole not very successful. The difficulties connected with the adjusting of the machine, still more the defective workmanship of the majority of them, have raised a feeling which will operate for a time against their general introduction. An improved machine, embodying the suggestion of the judges at Pusey, with some other alterations, will probably be brought out in the county.

The threshing machine has wholly superseded the flail, the smallest holding having some kind of threshing machine. The original form, as invented by Meikle, is still most esteemed. The peg-drum was introduced some years ago with great promise, but has proved all but a failure. The bolting-drum has also been adopted by one or two farmers, but has not equalled expectation. Both forms partially bruise and break the grain. All the machines in this county separate the straw and chaff from the corn. Some machines have two or more fanners attached, which prepare the grain for market. On most farms, however, the grain, after leaving the mill fanners, is put through hand-fanners preparatory to measuring. All the threshing machines are fixed as well as the motive powers. The most approved motive power is steam, which is destined at no remote period to supersede almost wholly horse and even water power. With new leases, steam-engines are generally erected. Water, except under peculiar circumstances, can seldom be economically applied, and is less under control than steam. The number of steam threshing mills already nearly equals the number of horse and water mills combined, while the actual horse-power is considerably greater. Horse-mills are now confined to small holdings, and water-mills seldom or never constructed. At the beginning of the present century, windmills, where water could not be applied, were much in favour. The original cost of construction is a serious bar to their adoption; besides other more serious objections. They have been wholly superseded in the county by steam-engines: the only remaining one, on the farm of Oxwellmains, has been this last summer displaced by a steam-engine. Since the 20th May six new engines have been erected; three horse-mills, two old steam-engines, with the above windmill, being superseded.

As we have a very decided opinion as to the superiority of the fixed over the movable engine for the purposes of the farm, we

have obtained from Mr. Bridges, engineer, North Berwick, the subjoined details as to the original expense, and annual average expense connected with their use. The engine and boiler house is usually constructed at the expense of the proprietor; the engine and threshing apparatus, of the tenant. The prices given are higher than they were some time ago, owing to the recent rise in material and labour. Mr. Bridges has erected a large proportion of those in use throughout East Lothian, and superintends the repairs. The average for repairs does not include any accidental breakage; but as the engines are very strongly constructed, such contingencies are all but unknown. Mr. Bridges writes us in reply to our inquiries—"I have divided the dressing apparatus from the mill; and were hummellers and foul-spout elevators deducted, so as to form a mill still extensively used, the price would be reduced, say 16*l*. The mill and dressing apparatus will be understood to prepare the grain ready for measuring up; at the same time it is not so well done as when finished by hand-labour on the old system."

Horse-Power.	Price of a fixed high-pressure Steam-Engine.	Price of Mill with Hummeller and Foul Spout Elevators.	Dressing Apparatus, including 2 Winnowing-Machines with Elevators.	Converting Horse-course into Engine and Boiler House, in ordinary cases.	Cost of a New Engine-house and Boiler House, in ordinary cases.
	£.	£.	£.	£.	£.
4	90	60	32	50	76
5	100	65	35	55	83
6	110	70	35	60	90

Average of repair for engine for first 19 years, under good management, per year, 2*l*.
For mill, per year, 2*l*.

The arable land of East Lothian extends to 107,269 acres; the number of threshing machines is 373. As each farm, however small, has some kind of threshing machine, by dividing the arable land by the machines, it gives 287 acres as the average extent of the arable farms in East Lothian. These, however, chiefly vary from 100 to 600 acres; 375 acres imp., being 300 Scotch, is considered a good size of holding. Some farmers occupy more than one farm, but these are exceptional cases, resident tenants being generally preferred. One homestead is the almost unexceptional rule, a Scottish farmer having a strong desire to have the whole under his own eye.

The farm-buildings are generally situated near the centre of the farm. The usual form of these is a square, the corn and straw barn occupying one side, the stable and cow-byre generally the

opposite. On the other two sides are feeding-byres or courts, also a cart-shed. The interior of the square is usually divided into courts for cattle. The material used in buildings is stone—frequently whin—but sandstone, if convenient, is preferred. The common roofing material is tile. The dwelling-house for the farmer is usually commodious and comfortable; roof, of slate; not so, however, with the accommodation for farm-labourers. This usually consists of a row of cottages in a continuous line; a separate one for the overseer being sometimes provided. The number of the cottages has reference to the size of the holding, the desire being to have all the persons employed on the farm resident, and at convenient proximity to the steading. A farm of 375 acres may have nine to twelve cottages. These consist usually of one single apartment, built of stone and lime; the interior of the walls roughly plastered; the roof of tile, seldom coom-ceiled; the floor of clay, mixed with ashes and lime; one door and two windows—one of these two or four panes of glass. Water is never introduced, and sanitary arrangements are all but disregarded, the sty for the pig being the only other erection for the convenience of the farm labourer. The more recently erected cottages are improved by having two, and in some instances three, apartments provided. These, however, being usually all on the ground-floor, would not be according to the taste of an English cottager. Another step in advance would be to build the cottages *detached*, and off the road at least ten yards. The farm-buildings are seldom wholly renewed—a system of patching being too frequent. The common result is inconvenient and ill-arranged steadings.

The outlay connected with the erection or improvement of farm-buildings is usually borne by the proprietor, the tenant almost invariably performing the cartage at his own expense. These buildings are generally erected by contract, but there is seldom any supervision except by the agent and farmer. When any alterations are stipulated for, a sum is usually agreed upon. The receipt from the contractor is produced by the tenant, and the sum covenanted for is deducted from the rent. Under such circumstances, the tenant often expends a larger sum than that stipulated for, but of course out of his own capital. The necessary repairs during a lease are borne by the tenants, who on some estates are bound to insure the buildings against fire.

The barn is usually of two stories. The threshing mill and motive power are fixed, and belong to the tenant, being removable at the end of his lease. The stable is constructed to contain all the farm-horses, whether the number be six, eighteen, or more. The courts for cattle are constructed to contain from six to ten. The sheds are made with one, two, or more open-

ings. The stalls for their turnips are in the open air, usually formed round the walls. In some instances these stalls are protected by sheds extending so as to shelter the cattle: the boxes for cake and corn are usually under cover. Where stall and box feeding are practised, courts are partly dispensed with; but a proportion of the cattle are always kept in open sheds. The opinion is at present in favour of box-feeding, but the practice is not extending very rapidly. In some cases the buildings surrounding the cattle-stalls have roans to carry off the rain-water; but these are exceptional instances. The stables are in most cases very indifferently constructed, ventilation not being studied, and too many horses crowded together under one roof. Stalls with mangers and racks are always provided for each horse.

The average size of the fields is about 20 acres, although fields of 40, 60, or even more, are not uncommon. The usual fence is thorn, which is generally trimmed close, and not allowed to exceed in height from 4 to 5 feet. In upland districts the beech mixed with thorn is preferred, this fence affording more shelter during winter; besides, the beech grows where the thorn is liable to die out. In those parts of the county where stones are abundant the fences are constructed of this material. Stone-walls are usually pointed with lime, this being done after they are built. If not the whole wall, the cope-stone is usually bedded in lime and pointed. The first planting of thorn fences in this county does not extend much further back than seventy years. Within forty years a considerable part of the county was unenclosed. Some of the best land in the neighbourhood of Dunbar is only partially enclosed. Fences, except on the road-sides, are deemed rather a hinderance to good cultivation.

About thirty years ago the first tile-drains were put in, but it is within a period of fifteen years that furrow-draining was commenced in earnest in this county, it being for a time behind other counties in Scotland in the adoption of this improvement. The thorough-drainage of the county is now nearly completed, the whole, with the exception of isolated cases, having been *effected by the tenants.* There are instances where the proprietor allowed the value of a part or the whole of the tiles; in others the tenant, by making it a condition, obtained from the landlord a part of the sum required to drain the farm; but these are very exceptional cases.

In connection with draining, the name of the Marquis of Tweeddale, the inventor of the Tweeddale tile-machine, suggests itself. His Lordship is at present the most extensive arable farmer, and one of the most distinguished improvers, in the county. The number of acres he cultivates is about 1000,

the number of farm-horses employed is about 30. By furrow-draining, deep cultivation, and latterly the application of moss, land naturally very inferior, and situated from 400 to 700 feet above the level of the sea, is not only producing green and grain crops equal to the best land in the county, but in the case of wheat the quality is even superior. Peat-moss, taken out of a morass, which morass is situated in a valley, is applied to the land at the rate of 100 tons per acre. The moss is raised and applied by a moveable railway, with steam-engines. By these improvements, land originally not worth more than 7*s.* per acre to rent is now worth not less than 40*s.*

One of the first things attended to by a tenant at the beginning of his lease is to complete the drainage as speedily as possible. This is usually effected during the first course of the rotation, in four or six years, there being but one opinion now among farmers as to the imperative necessity of effectually freeing the land of superfluous moisture, with the view of profitable occupancy. The sums obtained for this county, under the Government Drainage Acts, were very limited; and where applied to land let on lease the tenant had stipulated for the application, at the same time becoming bound during the period of his occupancy to pay the percentage. The usual depth of drains is 30 inches. Within the last few years 40 inches have become fashionable, inspectors under the Government grants insisting upon this depth. The distance between the drains seldom exceeds 18 feet. The material now generally used is pipes with or without collars: 1¾-inch pipes 14 inches long cost at the tileries from 21*s.*, with collars 28*s.* per thousand. The number of tileries is now reduced; there are still in operation, however, about ten, but bricks and roofing tile are their chief articles of manufacture. Those works which furnished the largest quantity of draining materials have stopped, and in some instances the buildings have been removed. But the drainage not yet effected, or only imperfectly done, will most probably be completed with the renewal or commencement of new leases.

The acreable produce of this county has been greatly increased from two causes—thorough-drainage and the application of guano. From the former the average extent under turnip has been quadrupled; from the latter the average weight of bulbs has been increased by at least four tons per acre. Without the aid of guano, manure for the breadth of land now capable of growing root-crops could not have been obtained. The *average* produce of wheat, from these two causes combined, has been raised not less than eight bushels per acre. If *ten* were named, it would not exceed the real increase. Barley and oats have also been increased at least by *twelve* or *fourteen* bushels; beans by *eight*

bushels; while potatoes could not be grown to one-half the present extent without these two powerful agents—thorough-drainage and guano.

The average weight of turnips grown may be estimated at 18 tons per acre. The swede occupies less than one-third; the purple-top yellow and white globe occupy the largest space. Since the introduction of Skirving's purple-top yellow, the swede has been restricted in breadth.

The average produce of wheat per acre for the whole county, for the last five years, may be taken at 31 bushels; barley, at 44; oats, 50; beans, 28; hay at 3360 lbs.; potatoes at $5\frac{3}{4}$ tons per acre. The average weight of wheat per bushel is 62 lbs.; barley, 55; oats, $42\frac{1}{2}$; and beans, 66. The weight of the straw is seldom ascertained, except in experiments. It varies considerably, being dependent on variety grown, season, and nature and condition of the soil. These averages are much above those in the Statistical Returns. (See Appendix.) It must however be kept in view that the crop of 1853 is confessedly below an ordinary average.

The obtaining of manure was, and still is, the great desideratum of the improving farmer. While the introduction of guano has supplied a new fertilizing agent, the increasing demands made upon the soil render the manufacture of farm-yard manure still an essential part of successful management. Previous to the introduction of portable manures, the feeding of stock was the chief source of supplying manure. In this county the keeping of stock has always been studied by the farmer; while at present, the feeding both of cattle and sheep is more extensively practised in East Lothian than in any district in Scotland. The stock are fattened partly for the profit realised, and partly for the purpose of converting the turnip and straw into manure. There is no particular breed of cattle connected with this county. With the exception of one or two herds of short-horns, the cows kept are Ayrshires, half-bred short-horns, and nondescripts. Cattle are reared by few farmers. The chief difficulty is the obtaining of calves sufficiently well bred, few pure short-horn bulls being kept. Where cattle are reared, they are usually fattened and sold off at two years old, at prices varying from 12*l.* to 25*l.* The great proportion of the cattle fattened is purchased. At one time Highland, Aberdeen, and polled Angus cattle were the only kinds fattened. The two latter breeds are now generally fattened in the districts they are reared in. Within the last 15 years Irish-bred cattle have been introduced in considerable numbers. Independent of the majority of these not being well bred, the hardships they usually underwent previous to their arrival in this county operated so much against their health and progress, that Irish-bred cattle are now more neglected. It

was found that they were more liable to attacks of murrain, pleuro-pneumonia, than Scottish or English bred cattle; also that when fattened they did not bring the same price per stone as cattle reared in Great Britain. For the last few years the great proportion of the cattle fed are half-bred short-horns. These are generally obtained from English dealers, who purchase them from the breeders, in the counties of York, Durham, &c. Occasionally they are purchased by farmers of the county at markets in the South.

The ages at which cattle are purchased for fattening are one, two, and three years old. The number of two-year olds greatly exceeds that of the other two ages. They are usually purchased in the months of September, October, and November. Within the last two or three years, calves four to six months old have also been brought from the South. The best descriptions of the English-bred cattle do not come to Scotland, partly because the best are retained at home, and partly because our farmers in general are not sufficiently impressed with the importance of quality in these cross-bred animals, quality being, for the purposes of the feeder, even a more important element in crosses than in pure-bred stock. The weight to which the animal will fatten, and the time required to fatten, are too exclusively the elements of consideration, and not quality. The latter, when at all taken into account, is placed last, and not where it ought to be, first. Scottish farmers, while generally alive to the importance of quality in the pure native breeds, do not sufficiently appreciate it in crosses generally.

Three-fourths of the cattle now fattened in this county are English bred; and after being fattened are purchased for the South, and *return nearly to the same localities in which they had been reared.* The finest qualities generally go to London; the second qualities into the manufacturing and mining districts of England. It is generally only the inferior cattle, at least the smaller sized, which are sold in the Edinburgh market. The railways, while assisting in changing the kinds of cattle fattened in East Lothian, have also changed the markets for them after they are fattened.

The rates for the conveyance of lean stock from, say, Yorkshire to East Lothian, is from 6*s.* to 7*s.* per head; from Newcastle, 3*s.* They are taken back fat at nearly the same rates. To London the charge for a truck of cattle is 6*l.* 13*s.* 6*d.*, and as each truck contains seven or eight cattle, the rate is under 1*l.* per head. Sheep per truck, 3*l.* 15*s.* Dead meat to London, 60*s.* per ton.

The cattle, while being fattened, are usually kept in open courts. When these are comfortable, and the animals of a quiet disposition, they are found to make nearly as great progress as

those fed in stalls or boxes. During fine weather, the rate of progress is found to be *equal.* Full turnips are generally given, the yellow and swedes being cut. The weight of turnip consumed is dependent on age, breed, condition, and size. The ordinary consumption varies from $1\frac{1}{4}$ to $1\frac{3}{4}$ cwt. per day: $1\frac{1}{2}$ cwt. may be taken as the average. For the first two, three, or four months, turnip alone is allowed. For the last six or ten weeks, linseed-cake or corn is given. Ten years ago cake and corn were used in considerable quantities; sounder views, however, on the profitableness of the employment of cake are rapidly extending. Some of the best feeders in the county now make use of little cake or corn, having been convinced that payment for the cake is not obtained, and that manure can be had cheaper in the form of guano than by consuming oilcake by cattle. The usual estimated allowance for the increased value of the manure when oilcake has been given is 30*s.* for each ton of cake; but many farmers now believe that guano to the value of 30*s.* (3 cwt.) is more profitable. The advancing, and we believe the sound, opinion is to apply guano liberally to the turnip crop to increase the weight per acre, and thus obtain roots for feeding rather than expend money on the purchase of oilcake, especially at recent rates.

The number of cattle fattened in the county bears a relation to the number of sheep and the weight of the root crops. The general calculation is, that one acre of turnips should feed $1\frac{3}{4}$ cattle; but as part of the turnip crop is given to farm-horses and to wintering cattle, and a considerable proportion also consumed by sheep, possibly the number of cattle fattened on turnips does not exceed the number of the acres of turnips. This, having been 16,260 acres in 1853, would give that as the number of winter-fattened cattle in East Lothian. In making our estimate, we do not overlook that generally each animal receives in addition a proportion of extra food, possibly to the value of 20*s.* to 60*s.* The usual rate obtained for full allowance of turnips for cattle is from 3*s.* 6*d.* to 4*s.* 6*s.* per week, 5*s.* being the extreme. When let by the acre the price ranges from 5*l.* to 8*l.* per acre, according to the weight of crop, situation, accommodation, &c. The turnips on the estate of Phantassie were annually let by public competition for several years. Extent between 100 and 200 acres: average rate nearly 9*l.*, to be fed off *on the land.*

The number of sheep reared on the arable farms is inconsiderable, though there are several flocks of pure Leicesters for breeding, the tup lambs being sold into other districts. For the last two seasons, especially last summer, a good many of the lambs usually sold fat have been hogged, and kept on to be sold when fat, farmers finding that they had to pay more for holding lambs than they were obtaining for their own in the fat market.

With most farmers the practice is to purchase cast-ewes, Cheviot, or half-bred Leicester and Cheviot, in autumn; these are served with a Leicester tup; the lambs are fattened afterwards, and the ewes sold during the spring and summer months.

The sheep fattened are principally Cheviots, Black-faced wethers; also hoggets, crosses betwixt the Leicester and Cheviot, and pure Cheviots. The sheep are generally folded on turnips. In spring these are occasionally cut and put in boxes, especially for hoggets. Linseed and rape cake, beans and oats, are frequently given towards the close of the period of fattening: the quantity allowed being generally 1 lb. per day, 6*d.* to 9*d.* per week is considered fair payment for keep; 1*s.*, however, is occasionally obtained for 10 or 12, or even more, weeks' feeding. The demand for turnips to take for sheep is yearly increasing, the feeding of sheep for several years having been so profitable. Turnips are either taken by the acre or at a fixed rate per week. The rate per week per head is from 4*d.* to 7*d.* (average 5*d.*) for Cheviot and black-faced wethers. When young sheep are fattened they are generally the property of the farmer. These are usually sold in May, June, and July, being kept over the spring months often for the sake of the fleece.

Three-fifths of the sheep fattened in the county go to English markets. Part are slaughtered at Dunbar, Musselburgh, and Leith, the carcases put into baskets, and consigned to salesmen in London, either by rail or steam-ship. When sheep are sent to manufacturing towns they are forwarded alive. The best qualities, such as Cheviots, and occasionally black-faced wethers, usually bring the top quotations in the London dead markets. Last season a considerable number of black-faced wethers were forwarded alive to Cheltenham.* When the carcases of black-faced sheep are sent to the English markets, it is usual to allow one or two of the heads to remain attached to the carcase, to show the breed. Lambs are also forwarded to London, &c., but generally alive.

In sheep, as in cattle, the English consumer usually outbids the Scottish for the best qualities.

The number of sheep fattened on turnips in East Lothian, and sold during the winter months, may be estimated at from 30,000 to 35,000 annually.

The number of sheep fattened partly on turnip and partly on grass, and disposed of fat during the summer and autumn months, is very considerable. These consist of ewes with their

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* Having this autumn bought a lot of these horned sheep at the Falkirk fair, I found that, though their conveyance cost nearly 4*s.* per head by rail, they were well worth the money on their arrival, and, not being choice about keep, preferring indeed heath at first, are likely to pay well for fattening in Berkshire, besides supplying very superior old mutton for family use.—Ph. Pusey.

lambs and hoggets. They are purchased in autumn and in spring—much the largest portion in autumn. The ewes, half-bred Leicesters and Cheviots, but principally Cheviots, are served with Leicester tups—the produce sold fat in spring—the ewes in spring and summer. The hoggets are usually crosses between the Leicester and Cheviot—part three-fourths and part half Leicester, also part pure Cheviot. The best bred are usually sold in the end of May and beginning of June—the pure Cheviot in autumn. Sometimes these are kept for a month or two on turnips.

By the statistical returns obtained on the 20th of May last, there were in the county 37,000 ewes and 29,600 tups and wethers; but as the lambs, which must have been all dropped before the 20th of May, were by some strange oversight not enumerated, at least 36,000 lambs require to be added to this number. About 28,000 of these may be sold fat as lambs. The stock kept on the hills is principally ewes, Cheviot. The lambs are usually sold in autumn, also the cast ewes, the stock being kept up by selecting the best ewe lambs. Those at two years old have lambs, and after having three, or in some instances four crops of lambs, they are sold to the Lowland farmer, who, after taking one crop of lambs, fattens ewe and lamb. The average stock kept on the Lammermuirs is about one sheep to 2 acres, supplemented by a limited extent of arable land for winter keep; and as there are 28,630 acres in sheep-walks, this would give about 14,300 sheep. Taking 12,000 as the ewe stock, the rest being tups and wethers, and as one-fourth of the ewes, the "ewe teggs," will have no produce, this gives the number of ewes having lambs at 9000. As the proportion of lambs to ewes is nearly equal on the Lammermuirs, this gives 9000 ewes and 9000 lambs. Part of these lambs are sold fat and part for stores. Average price from 12*s.* to 18*s.*; last year considerably above these rates. Ewes from 20*s.* to 34*s.* On some farms the ewes are served with Leicesters, and the lambs sold off when weaned.

The number of acres under alternate grasses is about 27,000. About one-fourth of this extent is cut for hay and soiling, the rest depastured. As the farm and breeding horses (with the exception of about 1000 soiled in the house), with nearly all the cows, are kept on the alternate grasses, and allowing fully an acre for each of these, amounting, horses and cows, say to 5000, this would give other 6000 acres as thus consumed, leaving 14,000 for cattle and sheep. About three-fourths of this are consumed by sheep, and as four sheep, part ewes with lambs, and part hoggets, are allowed per acre, this gives as the number of sheep being fattened on the arable land during summer 42,000. Occasionally cake is given to sheep on pasture—especially hoggets forward in condition. The profit obtained from this

addition usually covers the price of the cake. The average price obtained for the keep of a hogget is from 5*d.* to 6*d.* a week, ewe and lamb about 1*s.* a week. The hoggets when sold will weigh from 18 lbs. to 24 lbs. per quarter, a few superior above 28 lbs.; ewes from 16 lbs. to 30 lbs. per quarter. Fleece first clip weighs about 6 lbs. to 8 lbs., fleece of ewes about 4 lbs. Sold last spring at from 1*s.* 3*d.* to 1*s.* 6*d.* per lb. The permanent pastures amount to upwards of 6000 acres, one-half of which is consumed by sheep, the other by cattle and horses; and as each acre will keep at the rate of three sheep, this would give 9000 sheep, making in all 65,300. This number is rather under, but closely approximates to the statistical returns.

On the arable lands the proportion of ewes to hoggets, wethers, and tups is about one half; and as the proportion of lambs to ewes will be one and a quarter in the arable districts, there will be of ewes 25,000, of lambs 31,250. From the high rates of holding lambs, many farmers last season hogged the lambs. This would decrease the number sold fat by about one-third.

There are about 2000 Leicester, Southdown, and Cheviot ewes kept in the low districts for breeding tups; but as the number is so limited, and as they are sold fat after the breeding purpose is served, they are included in the above estimate.

The number of cattle, on the 20th of May last, was 7576, calves not included. One-fourth of these would be year-olds, reared in the county; one-sixth cattle which had been fattened on turnips, but not disposed of at that date; leaving 4700 as the number of cattle being fattened during summer, generally sold in autumn. Part of these are soiled, receiving cake along with grass and vetches. This will about balance the number we have given as year-olds. Average profit obtained from grazing 4*s.* a week. When cake is given, more is obtained; but cake is seldom given upon grass except the cattle have been receiving cake with full turnip during spring. Part of the depastured cattle receive turnip for a month or more before being disposed of.

The demand for grass-parks always raises them above their real value, being taken partly for accommodation and partly for speculation. They are frequently let by public auction, and average about 2*l.* 12*s.* per acre. For several years the alternate grasses on Phantassie were let by public sale—about 150 acres annually. In some particular seasons the best fields brought at the rate of 5*l.* an acre.

We may mention, that, as the permanent grasses are generally in connection with gentlemen's residences, they are usually so much shaded by trees dotted over the fields as to diminish the quantity of stock they are able to keep.

There are no dairies in this county, the dryness of the climate operating against the profitable following out of this branch of husbandry, at least by depasturing. The usual practice is to keep no more cows than are required for the use of the farm. When calves are reared, an extra cow or two are kept. Milk for the reapers is often purchased in Edinburgh.

Pigs are generally kept, but to no great extent. The young in some instances are sold, when taken from the sow, to hinds and others; on other farms they are kept and fattened, generally weighing when sold from 8 to 10 stones. Some farmers allow the young pigs to run among the cattle to pick up any waste food—others confine them. The number of pigs was 5580, sucking-pigs not being included. Nearly a half of these belonged to the farm labourers. The breeds of pigs have been greatly improved by the introduction of the Berkshire and Suffolk. There are few farms, however, on which pigs are sold to the extent of 100*l.* a-year—the general impression being that the keeping of pigs is not profitable beyond consuming the waste and very light grain of the farm.

The keeping of poultry is not extensively followed in this county, being kept more for convenience than as a source of profit. The proceeds generally in eggs, and occasionally turkeys, are regarded as the pin-money of the ladies of the farmer's family.

The number of horses in East Lothian is 4450; of these about 40 are race-horses in training at Gullane, and other 30 to 40 are Arabs and half-Arabs, a breeding stud at Dunbar. About 1300 may be set aside for carriage, saddle, and breeding horses. This leaves 3100 for farm purposes, or a pair of horses for each 70 arable acres. The number of acres a pair of horses can undertake is very much dependent upon the nature of the farm and the system of cropping. They may not be equal on some farms to more than 50, while on others they may reach even 100 acres. The horses used are chiefly the Clydesdale, partly reared, and partly purchased in the west of Scotland, in about equal proportions.* The period of service of the horse in East Lothian is com-

* The ploughing is performed by 2 horses yoked abreast. Sixty years ago, 4 horses, two and two abreast, was all but universal. The carting is now performed by single-horse carts. Thirty years ago, and even later, 2 horses yoked in line, *tandem,* was very common. This change is partly the result of improvements in the construction of the plough and cart, with better kept roads; also in a superior description of horses; still more, however, in the manner of feeding them. Sixty years ago, the horse was, during winter, seldom allowed oats. In spring, a few, with pea-straw, were allowed; during summer, he was compelled to pick up his food in the fields, always stabled during the night, and fed with thistles or inferior grasses. Now, during winter and spring, he always receives oats and beans, generally from 12 lbs. to 20 lbs. per day, and during summer he is either depastured, or, when kept in the stable, fed on cut grass or vetches.

paratively short: diseases of the chest, partly superinduced by the climate and partly by disregard to proper ventilation of stables, carries off in some seasons considerable numbers. Hard work with high feeding, especially in the spring months, also tells against the horse's period of service. On some farms the stocking requires to be renewed three times during a nineteen years' lease. The average value of good farm-horses at present is about 40*l.*; superior, 45*l.* to 50*l.* The saddle and carriage horses are inferior. A few of these are reared, but the Scottish farmer in knowledge of the points of these lighter breeds is far behind the Yorkshire farmer. The importance of a good dam is not properly understood.

One feature of East Lothian farming is the breadth under potatoes. Previous to thorough-draining, the introduction of guano, and the formation of the North British Railway, the growing of potatoes for sale was not found profitable. Since the appearance of the potato-blight the cultivation of this root has been greatly extended, and is very remunerative: in some seasons, such as the present, eminently so, the crop being large and with little disease. This season the potatoes are being sent principally to the English market, London taking the greater proportion. Railway carriage to London from East Lothian is 30*s.* per ton, in trucks of 5 tons; expenses connected with sale about 6*s.* to 7*s.* The returns of sales with proceeds generally reach East Lothian eight days after the potatoes are put upon the railway. The prices obtained, deducting all expenses, have been from 5*l.* to 7*l.* per ton; occasionally even above this. The most of the potatoes are, however, purchased by dealers in the county, and not sent direct to salesmen: prices given, from 5*l.* to 6*l.* 5*s.*

Lime is now seldom applied, and, when applied, generally in the form of compost. No attempts have been made in this county to apply liquid manure by distributing-pipes. Indeed, during dry winters and springs, difficulty is sometimes felt in reducing the straw into manure. Farm-yard manure when applied in autumn is usually in the rough state; when in spring, it is considerably decomposed by fermentation. It is especially necessary for the turnip-crop that the manure should be sufficiently decomposed and moist. The amount of farm-yard manure produced on a farm varies considerably, being from 8 to 16 tons per acre in the four-course rotation; under the six-course more straw is raised, and consequently more manure is obtained. Guano, however, is now all but the indispensable fertilizer, especially for the turnip and potato, and has nearly superseded other portable manures, nitrate of soda excepted. This latter, within the last year or two, has been applied to wheat with the best effect. Its application previously was con-

fined to top-dressing grass with and without guano. Such manures as ground or dissolved coprolites and manufactured manures have been frequently tested with Peruvian guano, and almost invariably with a uniformly unfavourable result. The deficiency of crop by the use of these, compared with guano, was generally greater than the whole outlay for the guano. Most farmers are now shy even in making experiments with manufactured manures.

The amount spent on guano in this county is very considerable. There are several farmers who purchase guano annually to the extent of 1000*l.*; and 400*l.* to 600*l.* is a *common* expenditure. The amount expended on portable manures over the cultivated portion of the county may be taken at 12*s.* to 18*s.* per acre. In one parish, Gladsmuir, of 6386 acres, the quantity of Peruvian guano applied last season was upwards of 400 tons; this year, for the same parish, already 500 tons have been ordered. The produce of the county has been greatly increased since the introduction of guano. Mr. John Brodie is of opinion that guano has increased the average produce of the wheat-crop something like 7 bushels per acre, and of barley and oats fully 8 bushels. Thorough-draining, with the use of guano, has doubtless greatly raised the aggregate produce. Allowing for seed, and the grain paid as wages to servants, with what is consumed by horses, the aggregate produce of vegetable and animal food which this county supplies for general consumption has been certainly doubled within no very distant period—say 20 to 30 years. The quality of the grain has also been greatly improved, the weight per bushel and general appearance being enhanced. Twenty years ago, in Haddington market, it was difficult to find a sample-bag of wheat without papple, or a sample-bag of barley and oats free of wild oats. The latter pest, although considerably reduced, is not extirpated as has been the case with the papple. The annual competitions for the premiums offered for the best seed-corn by the East Lothian Agricultural Society have contributed to this result, and the Society has otherwise tended to improve farm practice generally.

Another equally important result has been produced by the combined agency of thorough-draining and the liberal use of portable manures. Not only is the aggregate produce increased, but it is greatly less dependent upon the character of the season. Last season, 1852, was by far the largest crop ever reaped in East Lothian; and in the present season, 1853, confessedly *unfavourable*, the produce of those farms with high manurial treatment will be *above* an average, the wheat crop excepted. This will also be about an average in acreable produce, but restricted in breadth. This equalizing of the produce gives to

the *liberal* cultivator a great advantage in such a season as the present, when prices are so much influenced by a confessedly deficient crop, over the corn-producing districts of Europe; while its more general extension would render the country less dependent upon foreign supplies, and, with nearly equal profits to the cultivator, secure a less fluctuating range of prices to the consumer.

The crops in East Lothian are cut principally by sickle—occasional fields only being cut by the scythe. Last season a considerable number of Bell's reapers were in use, but comparatively little was cut by them. The labourers employed during the harvest are the resident population, with bands of Irish reapers, these coming partly from the north-west of Ireland, and partly from the larger towns in Scotland. About 12,000 of these strangers find employment during four weeks in harvest. Sometimes 100 reapers may be seen in one field, under the superintendence of the master and foreman. The average wage per day is 15*d.*, with food. The food consists, morning and evening, of a Scottish pint of oatmeal porridge, with milk, the porridge weighing about 5 lbs.; the dinner is a quart of harvest beer, with a loaf of wheaten bread, weighing 1 lb.* Each reaper is furnished with a blanket; they are lodged in the barns and outhouses. One person binds for every six reapers. The "stooks" (shocks) are set up in all possible forms, of 4, 8, and 10 sheaves. About five reapers cut and bind an acre per day. As soon as the grain is in a condition for being carried, this is vigorously prosecuted. Single-horse harvest-carts clear a field with great rapidity when all engaged in it are active. The stacks are generally round, occasionally oblong; 15 to 20 quarters of wheat, barley, and oats is the average size, but of course the grain contained in a stack depends on the productiveness of the crop and the amount of straw grown.

The progress of agriculture, like that of every other manufacture, is in no small degree dependent upon the intelligence, trustworthiness, and general carefulness of the workmen. The hinds of East Lothian have been long distinguished by such qualities; and any report on the farming of East Lothian would be defective which did not bear tribute to their general intelligence and trustworthiness. Nowhere does there exist more of that community

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* The writer, in certain ethnological investigations he conducted, found that the Irish reapers increased in weight very rapidly under this diet, "the halesome *parritch*, chief o' Scotia's food." The average increase the first week was 7 lbs., the second week rather less; the third, fourth, and fifth weeks showed a progressive increase. It may be interesting to record that out of several hundreds carefully measured, weighed, &c., Highland females from Skye equalled in average weight Irishmen of the same ages; the females of the county and of Ross-shire exceeded them by several pounds. The men of East Lothian weighed fully 30 lbs. above the natives of Ireland.

of feeling, and that friendliness of relation which ought to subsist between the employers and the employed, than in this county. The servants not only occasionally suggest improvements, but *endeavour to carry out what is novel*, whether in the adoption of new implements, or of what is new in practice. On some farms the same families have sustained the relation of master and servant for at least two generations. This, however, is somewhat on the wane, and indeed modern habits scarcely admit of this rather interesting feature in the domestic history of the past being preserved intact.

It may be mentioned as a striking proof of the general trustworthiness of the hinds, that a considerable proportion of the grain is sold by them in stock markets, they giving delivery and receiving payment. We have only heard of one instance where this trust was misplaced, every sixpence of the money being always faithfully accounted for.

The system of payment is somewhat peculiar, being a species of the truck system. All the hinds upon a farm receive the same "gains." One farmer only varies from another, if at all, to a very limited extent. The "gains" are 72 bushels of oats, 18 of barley, and 8 of beans; keep for a cow, or, in lieu thereof, 5*l.* in money; with about one-tenth of an acre of land for planting potatoes; house and garden, with liberty to keep a pig; coals driven, and food supplied during harvest. A few farmers also give 2*l.* for flax and hen-money. The keeping of a cow is a source of great convenience to the family, and supplies to them many comforts which they could not otherwise secure. It has also a marked moral effect, as the feeling connected with property generally elevates the tone of the possessor. The system of mutual insurance of the cows is very generally carried out by the hinds, the allowance for a cow being 8*l.*, about 2*l.* below average value. The prevalence of pleura-pneumonia four years ago has however very generally interfered with the working of these insurances. For the above items the hind gives his entire services (the period of work in the fields being nine hours), furnishes a reaper, without wages, in harvest for 21 days, and, where such a stipulation exists, also an outworker, generally a female, termed a "bondager," who, when employed, receives 10*d.* per day. The system of "bondager" has been loudly complained of by the hinds, and, from a general representation, this part of the engagement is now relaxed—many farmers not insisting on this provision, and trusting for the supply of labour to the families of the hinds, cottagers, and the itinerant Irish.

From the greater breadth of the root crops, and partly from an increasing number of the female population entering domestic

service, the demand for outworkers has produced a state of matters which will doubtless affect the future character of the rural population. Since 1847 a considerable number of Irish labourers, with their families, have sought work in this county, and many of these have become located, chiefly in the towns. This immigration has already affected the poor-rates, and, as in other districts of Scotland, will tend to lower the position of the rural labourer. The usual wage of day-labourers is from 9*s.* to 12*s.* per week, but drains are generally cut by the piece, and with this sort of piece-work higher wages are generally secured.

In East Lothian, as in Scotland generally, the terms of tenure are on lease, usually of nineteen years' duration. The period of entry is at Whitsunday to the grass and turnip break, with the dwelling-house, and part of the other buildings; to the remainder of the land after the separation of the crop; the outgoing tenant keeping possession of the barn, with a cot-house or two, till the following Whitsunday, for disposing of the corn crop. No arrangement could be more objectionable as regards the relations of the outgoing and incoming tenants. A Martinmas entry to the whole farm would prevent much of the annoyance inseparable from the present system. The straw is generally *steel bow*, and in some instances also the manure.

Antiquated and absurd clauses are to be found in almost every lease; leases being generally framed by lawyers unacquainted with agriculture. Such clauses are seldom insisted on: if they were, the system of modern farming could not be followed out. It is only when misunderstandings arise between the contracting parties that such clauses are brought to bear against the occupant. They are also partially insisted on towards the end of the lease. It may be mentioned as a somewhat striking anomaly, that the number of such clauses is not only increasing, but the clauses are being made even more restrictive. There is no subject bearing on Scottish agriculture which requires a more complete revision than the nature and terms of a lease.

The rent is generally fixed partly in money and partly in grain, the grain being usually wheat, to be calculated at the first or second fiars prices of the county for each year. In some instances the average prices of seven years are taken. It may be noticed the rent is all payable in money, not in grain. The terms of payment are generally Candlemas and Lammas, 2nd of February and 2nd of August, after reaping the crop. In some instances Martinmas and Whitsunday are the terms of payment. Grain rents, which were extensively adopted during the agricultural depression of 1822, are preferred by tenants, from some vague idea of money rents being difficult to pay in years of low prices. We believe, however, that mistakes are more frequently made in

offering too much grain than in offering too much money. Since the gold discoveries in Australia, this form of fixing rent is also preferred by many owners of land, there being a very general impression that the future supplies of gold are to enhance the exchange value of agricultural produce. The rent of land, whether in money or grain, is advancing with every new lease. Since 1847 the average increase has been about 15 per cent., scarcely one farm being let below, or even at the old rent. The highest money-rented farm in the county is 4*l.* 4*s.* per acre: the common rent for the best descriptions of land is ten bushels of wheat, by the second fiars prices of the county. From the recent rise of grain, this will most probably be 9*s.* per bushel, or 4*l.* 10*s.* per acre, if without a maximum. For last year the rent would be about 3*l.* As many of the leases have a *minimum* and *maximum* (not under 40*s.* nor above 70*s.* the quarter being the most frequent limits), the rent in such circumstances can never advance beyond 4*l.* 7*s.* 6*d.* per acre. On second-class lands, six to seven bushels of wheat may be taken as an average rent. Most of the land, however, let since 1847 is part in grain and part in money. From three to six bushels of wheat, with from 15*s.* to 30*s.* in money per acre, may be given as the range of present lettings. The average rent for the whole arable land in the county will be about 2*l.* 5*s.* per acre. Thorough-draining and guano are equalizing the values of good and inferior soils, the greatest advance being upon the inferior. Indeed, the largest acreable produce known to the writer in the county is from land naturally very inferior, a cold retentive clay resting on the coal formation. *The rent does not greatly exceed 20s. per acre. The amount paid to the guano merchant is 1000l., being at the rate of 2l. 6s. per acre.**

For several years the demand for land has been greatly on the increase. Never since the close of the war, 1814, has the agricultural interest been in a more prosperous state in this county than at present. There is, we believe, less deduction from the rent covenanted for than has ever been previously known. Perhaps there are not ten farmers in the county who are not paying the rent originally agreed on. We believe also that there is less of arrears than has been at any period, certainly since 1816. This presents a striking contrast to the history of East Lothian from 1822 to 1845.

* The extent of the farm is 430 acres. Previous to being furrow-drained turnips could not be grown. The only stock fattened were a few Cheviot ewes with their lambs: now, besides sheep, there are fattened about 100 cattle annually. Small Highland or Irish cattle are kept—average price when lean is from 3*l.* to 4*l.* After being kept for eight months in boxes they are sold fat. Average price obtained from 10*l.* to 13*l.* The straw and turnips are cut. During summer grass and vetches are given. Cake is also allowed. Sometimes bean-meal is also given.

The public burdens consist of statute labour and poor-rates: the former is paid by the occupant, the latter payable in equal proportions by owner and occupant. The statute labour is from 20*s.* to 40*s.* for each pair of horses; the average of the poor-rates is about 6*d.* the pound of rental. In Scotland there are no tithes, the Church establishment being upheld by a tax on the land, payable by the owner. The annual sum thus paid in the county, including the upholding of churches and manses, is a little above 4000*l.* per annum. The parochial schools are all but exclusively supported by the owners, although by law the tenant is bound to pay one half of the schoolmaster's salary. The annual amount for salaries, repairs of schoolhouses, &c., will not exceed 1500*l.*

The value of land to hire for agricultural purposes is greatly dependent on the facilities afforded by good roads for the conveyance of agricultural produce. The effect on the agriculture of a county by being intersected with a railway, for instance, is often very remarkable. In few counties has this been more strikingly displayed than in East Lothian, the North British Railway not only bringing the Edinburgh and Glasgow markets into close proximity, but even London, and the great manufacturing towns in the south. For example, potatoes, if carted from the east of the county to Edinburgh, could not be taken for less than about 30*s.* per ton, being the railway charge for the delivery of the same in London; that is, conveying goods 30 miles by cart costs as much as the conveying of them about 400 miles by railway. The same facilities of communication affect every article of the farm, whether manures, feeding stuffs, and lean stock brought to the farm, or grain, fat stock, or, this latter in another form, beef, mutton, &c., which are removed from the farm and conveyed speedily and economically to the best markets, however distant. Indeed, a railway is almost as essential to the agricultural prosperity of a district as thorough-draining itself. There is no doubt the North British Railway has very considerably increased the agricultural value of the county of East Lothian, and is greatly contributing to the development of its agricultural resources.

The history of the agriculture of East Lothian, since the end of the last century, teaches one lesson so emphatically, that it must not be overlooked in this Report. *Its record of improvements is almost universally that of those effected by the tenants themselves*, men of the highest intelligence, and many of them with considerable capital. With that history before us, we should fail in reading its most obvious and most instructive lesson, if we did not record in our Report of this county, that the most important source of its past and present agricultural position has been an enterprising and intelligent tenantry, and an educated and faithful class of farm labourers.

Having already exceeded the space suitable to a Report, I can only very briefly allude to the future requirements of the agriculture of East Lothian. These are nearly the same in Scotland as in England. The legislature can do much, but contracting parties can do more, to place agriculture in that position to which it may be raised. The legislature may aid the agriculture of the county by conferring greater freedom of action on owners of Entailed Estates, by repealing the Law of Hypothec (Law of Distress), and by abrogating those statutes which tend to foster a system of preserving wild animals in the midst of high cultivation. If, however, owners and occupiers of land understood better their mutual interests, which are so intimately associated with the application of capital to the soil, as the indispensable element of profitable occupancy on the part of the tenant, and an improved estate on that of the owner, arrangements on a mutually equitable basis would be made, which would greatly modify the operation even of adverse legislative enactments. A definite duration of tenure, at present universally enjoyed in Scotland, but requiring a more lengthened term; full security to the capital of the tenant, if not by law at least by contract; and a more general recognition of the principle that all *unnecessary* control over the management of the tenant is injurious to both parties,—these are points the importance of which to the agriculture of Great Britain it is impossible to over-estimate. The special wants of East Lothian are the providing of a better class of cottages for the farm labourers, better and increased accommodation for stock, the more general squaring of farms, with some minor details to which it is unnecessary to allude. As to practice, the keeping of the land flat, if in ridges at all; the more general use of two-horse grubbers in the cultivation of the soil, on the green crop break, especially in autumn and spring; the extended and more liberal application of guano, nitrate of soda, &c., to all the root crops, and in most instances on the grass and corn crops; the diminishing of the quantity of rye-grass and increasing that of the clovers; the confining of sheep to grazing on the alternate grasses, and in some instances the folding of these on pasture; the soiling of working horses and cattle, in place of depasturing; with more attention to their general health, that of horses especially—these are the principal points, by attention to which the practice of the county might be still farther improved, and the produce very materially increased.

Very faithfully yours,

CH. STEVENSON.

Edinburgh, Nov. 15, 1853.

Appendix.

With the view of more freely explaining the details of the farming of East Lothian, we subjoin a somewhat minute description of three farms in that county, which give a favourable, but at the same time a pretty correct view of the different practices of the county, each of the three occupants differing somewhat in opinion as to details, and consequently in practice. The first is Mr. John Brodie, Abbey Mains, a name familiar to those conversant with the agricultural evidence taken by Committees of Parliament. He is one of the oldest tenants in the county, having farmed for 60 years, and during all that time he has been one of the leading farmers of East Lothian. The public road to Haddington passing through his farms brought his practice more prominently under observation, while his farming has always presented features of such order and perfect management, as we are satisfied no model farm, if such were attempted to be established, would surpass, if it even equalled. Mr. Handyside has farmed both in Mid and East Lothian—in the former county having possessed Lochend, near Edinburgh, one of the best cultivated and highest rented farms in Scotland. Mr. H. spares no expense either for labour or manure, as the account of his farm will show. The prominent position which Mr. George Hope holds in agriculture renders any notice from us unnecessary. My grateful acknowledgments are due to these gentlemen for their acceding to my request to give the materials for preparing this part of the Report.

I also subjoin a few details of the farming operations at Greendykes and Markle, the tenant on the former having been for many years the most extensive and successful feeder in the county; the latter being the farm occupied, for about 40 years, by the celebrated Brown of Markle. From the length to which the Report has gone, I give the briefest notice possible.

Farm of Abbey Mains.

The farm of Abbey Mains is occupied by Mr. John Brodie, on a nineteen years' lease. It is situated about the middle of the county, distance from the sea about seven miles, exposure south, altitude from 120 to 250 feet. The lands rise gently from the river Tyne. The farm is free of wood, but is sheltered from the east and south by plantations; the extent is 455 acres, of which about five are occupied by buildings, gardens, and roads. Part of the farm rests upon whin-stone, and part on conglomerate; none of the rock comes to the surface, and the thickness of the soil above the rock is believed to be considerable. The subsoil is partly clay, and partly sand and gravel. The surface soil of the whole farm was originally inferior, part of it decidedly bad, being a cold thin moorish clay. Upon Mr. Brodie's entry, 27 years ago, the farm was very much out of condition. Upon obtaining possession, he commenced to drain with stones, the drains being cut across the slope. Material was obtained in the soil, the land being full of boulder stones; these were

brought to the surface, broken, and put into drains. Besides, upwards of 12,000 cart-loads of stones were brought from quarries. Mr. Brodie has always been a deep cultivator, consequently all the stones which interfered with the plough were removed and put into drains. The land was plain fallowed, lime applied, and wheat grown generally with rape-dust: the expense in one season on some of the fields for fallowing, removing stones, drains, lime, and manure previous to sowing the wheat crop, was 26*l.* per acre. The sum paid for lime during the first five years was 1360*l.* At first few turnips could be raised; these took the place of the plain fallow only after the land was thorough-drained. The straw was made into manure by cattle, generally polled Angus; these received a few turnips, and were afterwards fattened upon the grass. In 1832 furrow draining was commenced, and the whole farm has been gone over at an expense of about 6*l.* per acre. The price of tiles when draining was commenced was 66*s.* per 1000. The tile account for some years was about 200*l.* The sum allowed by the landlord was 1000*l.* for drainage and buildings. The outlay in draining the farm has been considerably above 2500*l.* At first drains were cut 24 to 30 inches deep. These were found on some of the fields not to dry the land thoroughly, and the tiles were relifted, and the drains cut 48 to 54 inches deep.

The farm is divided into 17 fields, the largest of which is upwards of 60 acres. The rotation is a seven-course, and is strictly adhered to, Mr. Brodie being bound by his lease to keep the land in grass two years. The rotation is—1, turnip; 2, wheat or barley; 3 and 4, grass depastured; 5, oats or barley; 6, beans or potatoes; 7, wheat. The following is the extent of the respective crops of the season 1852:—

Turnips . . .	72 acres.	Beans . . .	33 acres.
Wheat	91 ,,	Vetches . . .	7 ,,
Barley	49 ,,	Potatoes. . .	31 ,,
Grasses	117 ,,	Turnip-seed .	5 ,,
Oats	46 ,,		

The turnips cultivated are the Swede, Skirving's Purple-top yellow, and the White Globe. Fully one half is Skirving's Purple-top. The turnips are singled by hand, at a distance of 12 inches. In this Mr. Brodie differs from his neighbours generally, singling by the hoe being the common method.

The average weight of turnip is 22 tons; the whole is consumed on the farm, three-fourths by cattle, the remainder by sheep.

The wheat is usually sown in November and December; the variety chiefly grown is Hopetoun. No other kind indeed has been grown upon the farm for some years, till within the last two years. In 1852 an experiment was made with Fenton, Archer's prolific, and Hopetoun. The two former gave the highest produce. These three are now the varieties grown.

The highest average produce of wheat was in 1852, it being that season 45 bushels per acre; the lowest average was in 1848, being 31 bushels. The average produce of wheat may be taken at 39 bushels per acre, average weight 63 lbs. per bushel.

Barley is occasionally grown after turnip—variety Chevalier. The average produce for the last three years is fully 64 bushels per acre—the weight per bushel being 56 lbs.

The grass-seeds sown are of rye-grass 5 lbs. perennial, 5 lbs. Italian mixed with 7 lbs. red, 6 lbs. white clover, 4 lbs. cow-grass. This season Alsike clover is substituted for the cow-grass. In future the proportion of Italian will be increased and perennial diminished. The grass is occasionally top-dressed with 2½ cwt. of guano. This has a marked effect upon the fatness of the lambs, and is found a profitable application. The quantity of stock kept per acre varies according to the nature of the season; the stock being mixed, horses, cattle, and sheep, no correct estimate can be given.

The oat crop is grown after grass, the variety being the potato. The average produce is 63 bushels per acre—the weight per bushel about 44 lbs.

The variety of bean grown is the Scottish, mixed with one-fifth of peas—average produce about 35 bushels per acre. In 1852 it was 45 bushels.

The Regent variety of the potato is alone grown. The average produce of marketable potatoes has been about 6½ tons. The produce this year exceeds an average, being above 11 tons per acre.

The turnips, potatoes, and beans, are manured with about 9 tons of farm-yard manure and 3 cwt. of Peruvian guano. After the removal of the bean crop, a half-dressing of farm-yard manure, 5 tons, is given to the bean stubble—where this is not given guano is substituted. The average quantity of Peruvian guano purchased is 35 tons.

Mr. Brodie, in his evidence before the House of Commons in 1836, gives the following as the average produce of the nine preceding years, namely, from 1827 up to 1835, both years' crop included:—wheat, 29 bushels; barley, 43 bushels; beans, 26 bushels; oats, 48 bushels; potatoes, about 7 tons. It should be mentioned, however, that at this time he occupied Aimsfield Mains along with Abbey Mains, and that the produce of the former was greater than the latter, thus affecting the average. The estimate is therefore fully above what was obtained from Abbey Mains.

The average number of horses employed on the farm is 13. The mode of feeding is with oats and beans—two-thirds of oats to one-third of beans. Four feeds weighing 22 lbs. are allowed per day; one of these is of boiled barley and beans: their forage is bean-straw and hay. During summer they are grazed; taken up by the end of August. When hard wrought during summer, they receive a few oats. The horses are partly bred, and partly purchased.

A fixed steam-engine is the motive power of the threshing mill; a straw-cutter is also used. Mr. Brodie is of opinion that with a full crop it would now require six horses during the winter months to move the threshing mill.

Part of the cattle which are fattened are reared upon the farm, and part purchased. About 25 calves are reared annually for this purpose. 4 cows are kept. The calves receive milk mixed with linseed gruel till they are three months old. Afterwards, while on grass, they receive one lb. of cake daily. After harvest they are put upon half turnip, with a little oil-cake. When year-olds, they are grazed on first year's seeds. Cake is allowed from the beginning of August; by the middle of September they are put upon turnip, receiving what turnip they can consume till they are sold fat. During the last three months of feeding they receive 4 lbs. of cake, which is increased to 6 lbs. per day. Part are sold in March, and part in May. The average price for the last three years was 17*l.* 10*s.* Last year the whole were sold in March—part at 20*l.*, and part at 17*l.* 10*s.* At the present time (14th November) the year-olds are in good condition for the butcher, and if sold at present in the Edinburgh Market would bring about 15*l.* each. Mr. Brodie keeps a short-horn bull, and thus obtains well-bred calves, the bull serving the hinds' cows in the district, and the calves being purchased by Mr. Brodie.

About 40 cattle are fattened annually. There are upwards of 80 cattle, calves, &c., upon the farm. The cattle purchased are crosses of the short-horn—price this year (in October) 13*l.* 5*s.* They are fed in the same manner as the home-breds: the average sum left for keep is 5*s.* per week on those purchased. Mr. Brodie seldom gives cake and corn, except to finish off, not considering the practice profitable, though he has been occasionally well repaid for the use of these substances.

Mr. Brodie by *experiment satisfied himself that feeding in open courts is preferable to boxes.* The cattle are therefore all kept in open courts with sheds—the courts being 36 feet square, the sheds 36 feet by 16. Seven cattle are generally put into each court.

At one time Mr. Brodie kept a flock of Leicester sheep for breeding tups; this he has abandoned. The only sheep kept through the winter are draft ewes, crosses between the Leicester and Cheviot, which have lambs by Southdown rams. This cross is preferred to that from Leicester tups, the lambs bringing a higher price. The lambs are sold fat, also the ewes. About 120 ewes are purchased annually in September, and all sold off by August of the following year. The same stock has been obtained for the last four years, during which time the ewes have risen from 26*s.* to 31*s.* 6*d.*, the latter being the sum paid this year. The average payment for keep is about 30*s.*; last season it was upwards of 40*s.* It must be observed, however, that the stock is always well kept the time they are on the farm. Besides the ewe stock, about 200 half-bred hogs are purchased in May; these are fed upon grass, sold in autumn, and usually leave 6*d.* a week for keep for grass.

A few pigs are kept; the annual sum, however, realised for these does not exceed 20*l.*

The number of cows kept for servants is eight; these are grazed in summer, and kept in the byre in winter on straw and chaff.

The number of yearly servants is ten; they are paid in kind, receiving a free house; the annual sum paid for labour is 250*l.*; the outworkers receive 10*d.* per day; harvest wages last season were 123*l.*—estimated expense of food 50*l.*; one of Bell's Reapers was employed; tradesmen's accounts about 60*l.*; public burdens 35*l.*; rent per acre, about 5⅗ bushels, which is estimated at the second fiars prices of the county. It may be mentioned as a somewhat interesting circumstance that Mr. Brodie has occupied 500 to 600 acres of land for 60 years, during which time he has paid as rent betwixt 60,000*l.* and 70,000*l.*; taking an equal or even greater sum for labour, manure, &c., the amount of agricultural produce he has raised must have approximated to 200,000*l.*

West Fenton.

The farm of West Fenton, occupied by Mr. Peter Handyside, since 1822, and recently re-taken upon a 21 years' lease, consists of 560 acres, 5 of which are occupied with buildings, garden, &c. The land is comparatively flat, and does not exceed in altitude 40 feet. The soil is naturally a heavy clay loam; part rests upon the boulder clay and part upon the trap rock. The trap rock does not, however, greatly influence the character of the surface soil, so that the whole may be regarded as a loamy clay. The farm is laid out in large fields, the number being 19; the smallest consists of 26 acres, and the two largest about 60 acres each. The fences are thorn, kept closely trimmed, and are never allowed to be above 4½ feet in height. West Fenton, at Mr. Handyside's entry, was in high condition, he having followed Mr. John Brodie, whose present farm of Abbey Mains we have above described. Mr. H. drained at first with stones, these drains being what are termed *Scottice rummle* drains. In 1824 a field was drained with house tiles, three being used, one as a flat, and the other two forming the arch. These drains are still in good condition. In 1830 Mr. H. commenced to use the common drain tile with flat. Since then the whole farm has been drained, chiefly at a distance of 18 feet, and at a depth of from 24 to 40 inches. Mr. Handyside prefers 30 inches to any other depth, the subsoil being a stiff clay. In draining the farm, the sum expended was upwards of 2000*l.*, the whole being done by the tenant, 200*l.* excepted. The farm was nearly all limed by Mr. Brodie during his occupancy. Mr. Handyside has limed about 100 acres.

Two rotations are followed, the four and the six course. Under the four-course are two-thirds of the farm, the remaining third, the inferior soil, is cultivated under the six-course. The four-course is—1. Turnip; 2. Wheat; 3. Grass; 4. Oats. For the last two years barley has been grown in place of oats. The number of acres under the respective crops last season, with the

intended cropping for 1854, is as follows, the number of arable acres being 555:—

	1853.	1854.
Turnip . .	91 acres.	84 acres.
Potato . .	40 „	43 „
Wheat . . .	141 „	157 „
Grass . . .	127 „	117 „
Barley . .	77 „	86 „
Oats . . .	49 „	42 „
Beans . . .	30 „	36 „
	555	555

Mr. Handyside manures liberally, having found in his experience that liberal applications of manure are, if judiciously given, well repaid. For some years Mr. Handyside has brought from Edinburgh, by railway, a great quantity of stable and byre manure. During the season ending 1852 upwards of 1200 tons were thus obtained. The manure in Edinburgh cost from 4*s.* 6*d.* to 5*s.* per ton; railway carriage, 2*s.* 3*d.* per ton; cartage to the railway at Edinburgh, 1*s.*; from the station to the farm, 1*s.* Thus the manure laid upon the farm cost 9*s.* the ton. Mr. Handyside does not deem it prudent to continue the purchasing of this manure at these terms, partly from the land being now in the highest possible condition, and partly from the results of his experience of portable manures. The average yearly amount of guano for the last three years has been upwards of 50 tons, chiefly Peruvian. Last season there were also applied 9 tons of nitrate of soda. From the use of salt Mr. Handyside has found considerable benefit from its producing stiffer straw, and consequently a better braird of the clover-plant. The barley after grass, and indeed all the spring-sown grain, turnips, &c., receive about 2½ cwts. of guano per acre.

The average weight of the turnip crop is 21 tons; the kinds grown are Swedes and Purple-top yellow, one-third of the former to two-thirds of the latter, with a few acres of White Globe—one half-acre of White Globe being allowed for each score of ewes. The average produce of potatoes is 5½ tons. The average produce of wheat per acre is 35 bushels, but the average has been above this for the last four years. Crop 1852 is the largest Mr. Handyside has ever grown. There are still 8 stacks of wheat to thrash of that year's crop; and, should these yield as expected, the average over the whole wheat crop for 1852 will be 46½ bushels per acre. The variety grown is Hunter's. Mr. Handyside, after repeated experiments with almost every fashionable variety, has found Hunter's the best suited for his farm. The average produce per acre of barley is 49 bushels. In 1852 the average was a little above 70 bushels. Average produce of oats 60 bushels. In 1852 it was 68 bushels. The grass, with the exception of a portion kept for hay, is depastured, principally with sheep. The hay is saved to obtain aftermath for the soiling of the farm-horses. The average produce of beans is 32 bushels. In 1852 it was 48 bushels of beans and tares mixed. The farm is open, without any plantations or trees, and from its situation is often injured from high winds from the west, these coming down the open bay at Aberlady. The bean crop particularly is often injured from this cause, when these winds occur during the period of blossoming.

The number of cattle fattened annually is dependent on the condition of the animals when purchased, the rule being to purchase animals well forward in condition in September, for putting on the turnip crop. These are sold in December, January, or February. Others are bought in and sold off before or by the 1st of June. These latter are never put out to pasture. The price paid in autumn, 1852, was 14*l.*; this autumn, 15*l.* Mr. H.'s last sale of fat

cattle (November, 1853) was, 15 cattle at 19*l.* per head. These were purchased in April at 8*l.*—grazed two months, afterwards kept in courts on grass and tares, receiving 4 lbs. of cake daily—for the last two months fed on turnip, with 6 lbs. of cake. The cattle are usually purchased in the September and October Falkirk markets, half-bred short-horns being preferred. The number at present in the process of fattening is 74. The cattle are kept in open curtains with shedding, each curtain containing from 8 to 12 animals. After the cattle are two months on turnip alone, 4 lbs. of oilcake daily are given; this is increased to 6 till they are sold. The average price obtained for keep is about 5*s.* per week. Mr. Handyside would not feed cattle except for converting the straw into manure, the profits obtained from fattening sheep being greater. It may be mentioned, as showing the great change which has taken place in the number of animals fattened in East Lothian, that when Mr. Handyside entered on this farm, 1823, the number fattened was 15 annually, and 30 wintered, which were afterwards fattened off upon the grass. At that time the cattle were generally polled Angus. In 1833, 54 cattle were full fed, no sheep were fed on turnip, the whole sheep stock being confined to 100 or 120 half-bred ewes, Leicester and Cheviot. In 1833 there were about 200 ewes. The number of sheep now annually fattened is about 1000, there being at present about 200 ewes and 760 Cheviot wethers. The wethers are purchased in September or October, and generally sold in March. Oilcake is occasionally given, rather to lengthen out the turnip than with the expectation of payment for the cake. Mr. Handyside, however, prefers giving cake to sheep rather than to cattle. The usual price obtained for keep is 8*d.* per week per head. The sheep are folded, receiving additional space twice a week. Ewes are kept, half-bred Leicester and Cheviot. These are bought in autumn, generally the middle of September; the lambs and ewes are fattened, and sold to the butcher during spring and summer. The ewes cost, average price, about 30*s.*, this year 34*s.* Last year, ewe and lamb with fleece were sold at 60*s.*, much below their value, being sold early.

Mr. Handyside used last season about 4000 stones of hay in fattening cattle, but he is so satisfied that this auxiliary does not pay, that he will not again employ it, except in extreme cases.

Pigs are kept. About 30 are sold annually at 30*s.* each.

The number of horses kept for the first six years of Mr. Handyside's occupancy was 23. The number now required is 19. This number is kept up by breeding, two being reared annually. Mr. Handyside's manner of feeding is to give during winter 2 feeds of oats, weighing each $4\frac{1}{2}$ lbs.; in spring 2 lbs. additional, with beans, are allowed. A feed of boiled food is given at night. This consists of two parts potatoes, and one of Swedish turnip, mixed up with wheat-chaff. The weight of roots allowed to each horse is 28 lbs.; the fodder during winter is straw, in spring 16 lbs. of hay are allowed. Mr. Handyside has continued this system of feeding for 30 years.

The number of cows kept for the tenants' use is 2, for that of the hinds 7. The rest of the ploughmen receive 5*l.* in lieu of a cow's keep.

The number of yearly servants paid in kind is 11, with 4 paid weekly wages, 10*s.* per week; 10*d.* per day is paid to out-workers. The sum annually expended for out-workers and extra labourers is above 400*l.* Harvest wages 120*l.*; harvest food about 70*l.*

West Fenton was taken in 1822, at an annual rent of 1220*l.*, the tenant becoming bound to expend 1000*l.* on dwelling-house, steading, &c. Upwards of 1200*l.* were thus expended. In 1835 the rent, 1220*l.*, was converted into 370 qrs. of wheat, payable by the second fiars prices, and the lease extended. The present rent is also in wheat, and is between 15 and 20 per cent. above the rent of 1835. The annual public burdens are, statute labour about 14*l.*; poor-rates under 20*l.*

Fenton Barns.

The farm of Fenton Barns, occupied by Mr. George Hope on a 21 years' lease, is situated in the north division of the county, about 3 miles from the sea; altitude under 100 feet; exposure, south-west. Although sufficiently undulated for drainage purposes, it is comparatively level; it is also open and free from plantations. The extent of the farm is 664 acres, of which 12 acres are occupied with buildings, gardens, &c. The fences have all been put in since 1793, being completed so late as 1815. Two-thirds of the farm rest upon the trap-rock, one-third upon the boulder clay. The depth of this bed of clay has not been ascertained, but has been found to exceed 30 feet. The soil resting upon the clay is indifferent; part of it is moorish sand, the whole of which, a few years ago, was yellow in colour, and unsuitable for the growth of wheat. By draining and dressing the sandy portions with the boulder clay, and *vice versâ*, it has become a useful soil. This portion of the farm, at the close of the last century, was uncultivated, and covered partly with furze-bushes, these being confined to the places where the clay came to the surface. The soil resting upon the trap-rock is superior, especially where the rock is in the form of basalt. On the other portions it is more of a thin clay than a fertile loam. The whole soil originally was more or less retentive, but has been changed in character by furrow-draining and a long course of liberal manurings. The farm has been in possession of the same family for upwards of 60 years. Before it was thorough-drained it was with great difficulty that possession was retained, the produce being so very uncertain. It was only the extra produce of favourable seasons—dry, with a high average temperature—that carried the farm through the bad seasons. Since the drainage has been completed the crops are not only more equal, but the average produce equals that of the former favourable years. This is, in part, owing also to the use of portable manures. The whole farm has been limed. From 1814 up to 1822, large sums were annually spent, some years amounting to half the rent, which, at that period, was 1706*l.* The average expense for lime was about 7*l.* per acre. As showing the rise of rent in the county within a period of sixty years, it may be mentioned that the rent in 1793 was 810*l.*; in 1814 the rent was increased to 1710*l.* This sum was changed to 450 quarters of wheat in 1822, calculated at the second fiars prices of the county. A new lease has just been entered upon; the present rent is a rise of between 15 and 20 per cent., still computed by the fiars prices.

The farm has been all thorough-drained within the last 20 years, the tenant doing the whole at his own expense, 300*l.* excepted. Permission to manufacture drain-tiles being obtained, these were made both for the use of the farm, and also partly for sale. Charging the tiles used in the drainage at the sale price, the sum expended on tiles and cutting the drains was upwards of 2500*l.* From experiments, which have been made public, Mr. Hope has formed very strong opinions as to the *inutility* of deep-drainage on such soils as his own—stiff retentive subsoils, free of under-water. The depth he prefers is 30 inches; the distance between the drains is 18 feet, as it was found that drains 4 feet deep and 36 feet apart did not dry the land sufficiently to admit of sheep-folding on turnips. The whole farm has been thorough-drained, up the slope of the land. The old drains, formed of small stones and cut across the slope, are still in active operation, carrying off spring-water. In the estimate of the expenditure incurred by the tenant in draining, these are not included.

The farm is divided into 27 fields by thorn fences, which are trimmed close, and not allowed to exceed in height 4½ feet. The three largest fields consist of 40 acres: the average size is 25 acres. Rotation is not strictly adhered to, the desire being to have as much of the land under green crop as possible, one-fifth of the farm being usually under grass. A part of the farm, extending

to two-thirds, is managed under a 5-course shift, the remainder under a 6-course. The 5-course consists of:—1. Turnips. 2. Potatoes. 3. Wheat. 4. Grass-seeds. 5. Oats. The 6-course is:—1. Turnip. 2. Wheat or barley. 3. Grass-seeds. 4. Oats. 5. Beans or potatoes. 6. Wheat.

The following is the number of acres under the respective crops for last year, with the intended cropping for 1854. Extent of the arable land 653 acres:—

	1853.		1854.	
Turnip	102	acres.	98	acres.
Potato	92	,,	94	,,
Wheat	122	,,	159	,,
Barley	68	,,	49	,,
Grass	129	,,	130	,,
Oats	88	,,	85	,,
Beans and vetches	43	,,	30	,,
Turnip-seed	6	,,	5	,,
Permanent grass	3	,,	3	,,
	653	,,	653	,,

The varieties of the turnip cultivated are Purple-top Swede, Purple-top yellow, and a few acres of White Globe. The average weight of bulbs is 23 tons per acre; the whole are consumed by stock upon the farm, about one-half by cattle, the other half by sheep; swedes occupy fully one-third of the whole. The cattle kept are usually half-bred short-horns. Feeding on turnip commences by the beginning of October, sometimes by the second week of September. The yellow variety lasts up till about the end of January, after which swedes are given. The usual period the cattle are kept on turnip is about five months. For the last two months or more they receive, in addition to turnip, 5 lbs of linseed-cake, principally foreign, the average price of which is 7*l.* per ton. Some seasons, when the prices of grain are low, oats bruised and beans ground into meal are also given. When grain is given, the cattle receive cake and corn each alternate day. The quantity of grain allowed per day is 7 lbs. By the end of the period of feeding cake alone is given, it being found that the cake gives the cattle a finer touch. Last year the quantity of cake consumed by cattle was about 25 tons, of oats 90 quarters, and of beans 20 quarters; in addition, about 3000 stones of hay, 22 lbs. to the stone, were also given. The hay was cut, and given mixed up with the oats and bean-meal. The number of cattle fattened last year was 74; in addition, 20 cattle, on half-turnip, were kept during winter; these were kept in courts during summer, and are now on turnip. The average payment for keep per week is about 5*s.* 6*d.* for cattle, which, when fattened, generally weigh about 50 stones imperial. The average period of fattening is about 5 months. Last season the return for feeding was much above the average. All the cattle are kept in open courts with comfortable shedding. At present (November) there are 90 cattle on the farm.

The sheep fattened are usually Cheviot and black-faced wethers and half-bred hogs, a cross between the Leicester and Cheviot. The numbers last year were—of Cheviot wethers, 260; of black-faced, 400; of half-bred hogs, 240. In addition, a breeding-stock was kept during winter, amounting in number to above 500, with 200 young half-bred Cheviot hogs; above 100 of the old ewes were sold fat, also their lambs. The breeding-stock kept is partly pure Leicester, Southdowns, and a cross between the Leicester and Cheviot. The number of sheep on the farm at present is about 1200. About 50 shearling Leicester rams are annually sold for breeding purposes; the average price is 4*l.* 4*s.*; also a few tup-lambs are sold, average price 3*l.*. A portion of the breeding-stock is grazed during summer on adjoining link lands in the possession of Mr. Hope.

The manner of feeding is by folding. The folds are enlarged twice or thrice a week, Mr. Hope having found that the oftener the sheep get a new fold the better. The sheep are always allowed to fall back upon the ground cleared. In spring the turnips are cut, and put into troughs for the hoggets. Cake is allowed along with the turnip after the middle of December; the quantity is 1 lb. per day. Two days in the week beans are substituted for the cake. Hay is also given; the quantity consumed last year by sheep was 3000 stones; the wet and afterwards the continued frosts causing them to eat more than the usual quantity. The amount of cake eaten by sheep last season was 35 tons, of beans 20 quarters. Owing to the high price of linseed cake and corn, Mr. Hope intends this season to use much less of these feeding substances than he has been doing in former seasons.

The number of pigs kept is about 100; part of these are sold when weaned, and part after being fattened for the butcher. The sum annually realized for pigs is about 160*l.*; they are fed on the refuse of potatoes; these being steamed along with turnips and mixed with a little bean or barley-meal. In summer they are fed on grass and tares.

The potato follows the turnip on two-thirds of the farm. This system was originally adopted for the purpose of freeing the land of wild oats, the greatest pest of the vegetable family in the county. It was found to answer so well, both for this purpose and also for profit, that it has been continued. The number of acres last year under potatoes was fully 90 acres; the average produce of sound marketable potatoes is, of Regents 7 tons, of Reds 9 tons; this year's produce considerably exceeds this, the Regents averaging 8 tons, the Reds 11 tons. The potatoes are usually sent to Glasgow, London, Manchester, Birmingham, and other English towns; of course by railway. For the last few years the potatoes have in this district been comparatively free from disease, consequently the profits obtained from their cultivation have been very large. In 1836 no potatoes were grown for sale.

As the half of the turnip-crop is consumed along with cake by sheep on the land, farm-yard manure is not directly applied to the potato-crop; 4 cwt. of Peruvian guano being the only manure given. The potatoes, when grown after oats, are manured with 15 tons of farm-yard dung, applied to the stubble previous to the land being ploughed. In spring, when planted, they also get 4 cwt. of Peruvian guano. The guano is applied in the drill before planting the potato.

The wheat-crop is sown usually in October and November: the variety grown is Fenton. There is applied as a top-dressing in spring about 3 cwt. of Peruvian guano. The wheat-crop is generally a full one, but, as the Fenton variety is a stiff-strawed wheat, comparatively little of it is lodged. The average produce of wheat over the whole farm is 40 bushels; the average weight per bushel is 63 lbs. The highest weight grown in any season was 65½ lbs., threshed during the summer months. As showing the great increase, it may be mentioned that Mr. Hope's father, before the House of Commons in 1836, gave as the average produce of 175 acres of wheat (excluding seed, 45 qrs.), 385 qrs. for the years 1828, 29, 30, and 31; and as the average on the same extent, 607 qrs. for 1832, 33, 34, and 35. Mr. Hope last year (1852) had from 133 acres nearly 750 qrs. The quantity of seed allowed in October is 8 pecks; in November the quantity is increased, but is regulated according to weather and condition of the land at the period of sowing. The grass-seeds which follow the potato-wheat have been found to succeed admirably. The quantity of clover-seed is 9 lbs. of red, 6 lbs. of white, 1½ lb. of yellow, with 4 lbs. of rye-grass. The seeds are put in at the time the wheat is top-dressed, and are either harrowed in, or, when the wheat is drilled, hoed in by either a horse or hand hoe. The grasses are depastured or cut for hay or for soiling: about one-third being cut, the other two-thirds

depastured. The whole grass-land, with the exception of about 20 acres, is ploughed up the first year for oats; the grass kept for two years being only retained for the use of the ewe stock, it being found that two years' grazing does not generally improve the after crops. The whole grass is top-dressed with 84 lbs. of nitrate of soda and 170 lbs. of Peruvian guano per acre; without nitrate about 3 cwt. are applied. The oat-crop follows; the land is ploughed in December and January, the oats sown in the end of February or beginning of March, but February is preferred if the weather admits of sowing. The variety principally grown is the potato-oat. The average produce per acre is 66 bushels; the weight per bushel of the potato is 44 lbs., of the Flemish 42 lbs. per bushel.

Where barley or wheat is sown in spring after the turnip, the grass-seeds are sown and hoed in. The Fenton wheat is found to answer equally well sown in spring or autumn. The variety of barley grown is the Chevalier. The average produce of barley is 52 bushels; the weight per bushel varies from 56 to 57 lbs.; the highest weight ever grown was 58 lbs.

The bean-crop, when grown, is taken after oats. About 15 tons of dung are applied in the drill at the same time; along with this about 3 cwt. of guano are given per acre. Formerly very small crops of beans were grown, but for the last three years the average produce has been about 38 bushels, the average weight being about 66 lbs. The variety is a small English bean.

The sum annually expended on manures, chiefly portable, is about 800*l.* In this sum is included 30*s.* for each ton of cake or corn consumed by feeding stock. Peruvian guano is most esteemed. Last year upwards of 60 tons were applied to the farm. Mr. Hope is of opinion that, *unless portable manures are applied at the rate of* 1*l. per acre over the whole farm, he could not continue to farm with a profit.* In 1836 the sum spent on portable manures was 150*l.* annually, the manure being rape-dust.

Although the farm is almost a square, and intersected with public roads, which give easy access to most of the fields, yet, from there having been originally two farms, the farm offices on both are retained. At each steading there is a fixed steam-engine, with threshing-machine. Servants and horses are kept at each steading. There are also courts for cattle.

The number of horses employed is twenty, being nine ploughs and two horses for orra work. A horse and gig-horse are kept for the farmer's use. The horses are generally bred on the farm. When any are purchased they are obtained at two years old. The feeding during winter is 15 lbs. of oats daily for each horse; the oats are given bruised. The fodder is straw in spring, and for one month in autumn. During summer half the quantity of oats is allowed. The young horses are turned out to graze during summer, the older horses performing all the necessary labour.

The number of cows kept is 17, 4 for the tenants' use; a few calves being reared. The number of cows belonging to the farm labourers is 13. Mr. Hope considers that a cow is of the greatest possible benefit to the family of a labourer. The cows are grazed on the farm, and kept on straw during the winter months. Two cart-loads of turnip are allowed to each.

Farm Labourers.—Of these 14 are yearly servants. They are paid in kind. The half of the oats is guaranteed to be not less in price than 26*s.* 8*d.* per quarter. They receive in addition 2*l.* in money, and half a boll of wheat. They pay for their house and garden on an average 25*s.* yearly. Outworkers are paid 10*d.* per day; during potato-lifting they receive 1*s.* The average time of working is about 9 hours; during summer the time is 9½ hours. The sum paid for outworkers and labourers engaged by the week is about 400*l.* Harvest expenses, with food, are yearly about 200*l.* A Bell's Reaper was employed this season. For tradesmen's accounts about 100*l.*; public burdens, 40*l.* annually. The expense of keeping both engines, with threshing mills, in

repair is under 5*l.* annually. The expense of threshing and dressing grain for market is computed for wheat at 1*s.* 4*d.* per quarter; oats, 9*d.*; and barley, 1*s.* per quarter.

Greendykes.

Greendykes, occupied by Mr. Archibald Cuthbertson, extent 434 acres. On the 20th November there were being fattened 67 cattle, half-bred short-horns, reared in England; average price, when purchased in September, fully 18*l.** Also 500 half-bred wethers, a cross between the Leicester and Cheviot, and 140 black-faced wethers. Mr. C. always purchases cattle well forward in condition, sometimes nearly fat, and changes two, three, and even occasionally four, times during the season. He considers that, when the cattle leave 5*s.* per week for keep, he is paid; average payment hitherto fully 6*s.* The average payment of sheep on turnip is 9*d.*, on grass 6*d.* Mr. C. now seldom uses cake or corn, except to finish off the cattle. When cake is allowed, 6 lbs. are given. He is of opinion that cake, when given, should never be continued beyond from two to three months, and not less than six weeks. The same rule he finds to apply in changing cattle from turnip to grass, and *vice versâ;* as with entire change cattle, for the first three weeks, usually lose condition. Mr. C.'s average payment from turnip for several years, whether consumed by cattle or sheep, is nearly 8*l.* per acre. One-fourth of the farm is generally under turnip, and, from the soil being a stiff clay resting on the coal formation, this has only been rendered practicable by thorough-draining, liming, and the liberal application of guano. The distance of the drains is 18 feet, the depth from 24 to 42 inches. Mr. C. finds that, with the 24-inch drains, the land is sooner dry after heavy falls of rain. For the last ten years the turnip break has not been ploughed in spring: by avoiding ploughing in spring, a fine tilth is always secured, and generally the crop braids well, and produces great weights. For the last fifteen years barley is generally taken after grass, in place of oats, and, with guano, great crops are produced. About 40 tons of guano are used yearly; last year 5 to 6 tons of cake. Average produce of wheat crop, 40 bushels; barley, 68; oats, 70; beans, 37. The whole management is very superior.

Markle.

Markle, occupied by Mr. Wm. Christie, extent 551 acres, waste about 30 acres, resting part on the red sandstone and part trap-rock—most of the farm a somewhat stiff clay. This, generally considered the best inland farm in the county, was let in 1852 on a 21 years' lease, at 417 quarters of wheat, second fiars, and 405*l.* in money, being a rise of about 5*s.* an acre over the previous rent, and being about double the rent paid by Mr. Brown during the average of his two leases. This farm produces the finest quality of grain, and is also celebrated for its feeding properties. Fully one-third of this year's wheat crop is already threshed and sold for seed; average price from 76*s.* up to 90*s.* per quarter; average crop this year about 37 bushels per acre; average weight from 63½ to 64 lbs.; highest weight in any season 65 lbs. Average produce of wheat for the last six years, 39 bushels; barley, 52; oats, 58; beans, 32; potatoes, 8 tons. The land is grazed two years; average payment of grass, besides keeping 19 farm-horses and 10 cows, 55*s.* The sheep kept are half-bred ewes; average price about 30*s.*; this year 34*s.* Last season 120 ewes produced as follows:—for wool, 35*l.*; 20 lambs at 28*s.*, 50 at 25*s.*, 120 at 22*s.*; ewes sold fat at an advance of 4*s.*; in all, deducting 3*l.* 8*s.* for 2 ewes that died, 32*l.* 2*s.* Besides these, hoggets are generally grazed: obtained for their wool last year, 60*l.*—

* This price must not be taken as anything like the average price paid for lean stock brought to the county; the average price certainly does not much exceed 9*l.* per head. This year, from the high price of lean stock, and the deficiency of the turnip crop, more than the usual number of year-olds have been purchased.

the number being 150 Cheviots sold fat during summer. At present (20th November) there are 120 half-bred ewes, 120 half-bred lambs, besides a few other sheep. When black-faced wethers are fattened on turnip, average payment 9*d.*; Mr. Christie finds the sheep make the greatest progress when the turnips are given in a grass-field, a fresh supply daily; average payment from turnip per acre, 7*l.* 5*s.* There are also at same date 71 cattle feeding, purchased in September; 19 half-bred polled Fife, at 18*l.* 5*s.*; 17 Galloways, at 13*l.* 15*s.*; 28 half-bred short-horns, 2½ years old, 9*l.* 10*s.*; 7 year-old home-breds: average payment from cattle-feeding, 5*s.* per week. Cake is only given to finish off. Last year there was expended on oilcake 140*l.*, and 50*l.* on beans; on manures, about 300*l.* Part of the cattle are kept in boxes and part in courts. They make about equal advance. During cold weather those in the boxes make the most progress; in spring, those kept in open courts. The expense of labour last year, excluding grain for 9 hinds, was 635*l.* 13*s.* 6*d.*; average is about 700*l.* The farm is cultivated on the 7 course, 2 years in pasture. The tenant expended, during his last lease, on lime and draining, nearly 2500*l.* The outlay has been judicious, and the occupancy during the last 19 years profitable.

LIST of STEAM and WATER ENGINES, &c., applied to Agricultural Purposes in the County of HADDINGTON, on May 20, 1853.

No.	Districts.	Machines.	No.	Average Horse-power of each Machine.	Total Horse-power.
1	Parishes of Haddington, Gifford, Bolton, Morham, and Garvald	Steam-engines	36	6	216
		Water-wheels	17	6	102
		Horse-machines	28	5	140
2	Pencaitland, Fala, Salton, Humbie, and Ormiston	Steam	26	5	130
		Water	17	5	85
		Horse	18	5	90
3	Prestonpans, Tranent, and Gladsmuir	Steam	28	6	168
		Water	3	4	12
		Horse	21	4	84
4	North Berwick, Aberlady, Athelstaneford, and Dirleton	Steam-engines	38	6	228
		Water-wheels	2	6	12
		Horse-machines	15	4	60
5	Prestonkirk, Whittingham, Stenton, and Whitekirk	Steam	26	6	156
		Water	15	6	90
		Horse	15	5	75
6	Dunbar, Innerwick, Spott, and Oldham Stocks	Steam	31	5	155
		Water	27	5	135
		Horse	10	5	50
			373		1988

ABSTRACT.

185	Steam-engines, giving the power of	1053	horses.
81	Water-weeels " "	436	"
107	Horse-machines " "	499	"
373		1988	"

ABSTRACT of RETURNS of the AGRICULTURAL STATISTICS of HADDINGTONSHIRE, on the 20th May, 1853.

District.	Imperial Acres.		Number of Acres under different kinds of Crop.															
	Total.	Arable.	Wheat.	Barley.	Oats.	Rye.	Beans and Peas.	Vetches.	Turnips.	Potatoes.	Man-gold.	Carrots.	Cabbage.	Flax.	Turnip Seed.	Alter-nate Grasses.	Improved Permanent Grass Inclosures.	Irrigated Meadows.
1	31,861½	24,929¼	2,640	3,163½	4,312¾	. .	817¾	275¾	3,561¾	606¼	7¾	. .	3	. .	15½	7,289	1,245	15
2	23,430	16,602¼	1,978	2,248	2,951¼	. .	453	189½	2,430	403¼	. .	2½	1¼	. .	30¾	4,634	658⅜	36½
3	13,963½	13,236¾	2.149	1,898½	1,826¼	. .	711¾	114½	1,816¼	1,000½	8	33½	9½	. .	46¼	2,605	796	. .
4	21,024½	17,796½	3,349½	2,251½	2,444	2½	936¾	156	2,874¾	1,058¼	19	55¼	1¼	. .	18¼	3,497½	900¾	7½
5	28,160¾	18,327	2,952⅜	1,712	2,708¼	3¾	1,118½	185¾	2,935¼	617¼	10¾	7¼	¼	. .	15⅝	4,179¾	1,676½	. .
6	30,733½	16,378	2,270½	1,536¼	2,559½	40½	771¼	90¼	2,642	561	2¾	8½	½	. .	31¼	4,679¾	951½	28
	149,173½	107,269¾	15,339⅜	12,809¾	16,802	46¾	4,809	1,011¾	16,260	4,246¾	48¼	107	15¾	. .	157⅝	26,885	6,228½	87

District.	Number of Acres not in Crop.					Amount of Stock.					
	Bare Fallow.	Sheep Walks.	Houses, Gardens, Roads, Fences, &c.	Woods.	Waste.	Horses.	Milk Cows.	Other Cattle.	Ewes.	Tups and Wethers.	Swine.
1	949¼	3,694	460½	2,714¼	90¼	950	496	1,339	9,506	5,582	1,203
2	566	4,242	363½	2,122¾	119	622	315	1,325	5,248	4,835	755
3	218¾	. .	332	300	97¾	702	274	1,084	1,638	2,953	906
4	153	1,147	471	1,280½	400¼	798	412	1,444	3,477	3,610	1,078
5	125¾	7,133½	578½	1,814	385½	690	429	1,470	6,586	7,184	852
6	114½	12,414¼	381	1,082¼	568	688	451	914	10,524	5,433	786
	2,127½	28,630¾	2,586½	9,313¾	1,660¾	4,450	2,377	7,576	36,979	29,597	5,580

Districts.
No. 1. Parishes of Haddington, Gifford, Bolton, Morham, and Garvald.
No. 2. ,, Pencaitland, Fala, Salton, Humbie, and Ormiston.
No. 3. ,, Prestonpans, Tranent and Gladsmuir.

Districts.
No. 4. Parishes of North Berwick, Aberlady, Athelstaneford, and Dirleton.
No. 5. ,, Prestonkirk, Whittingham, and Whitekirk.
No. 6. ,, Dunbar, Innerwick, Spott, and Oldhamstocks.

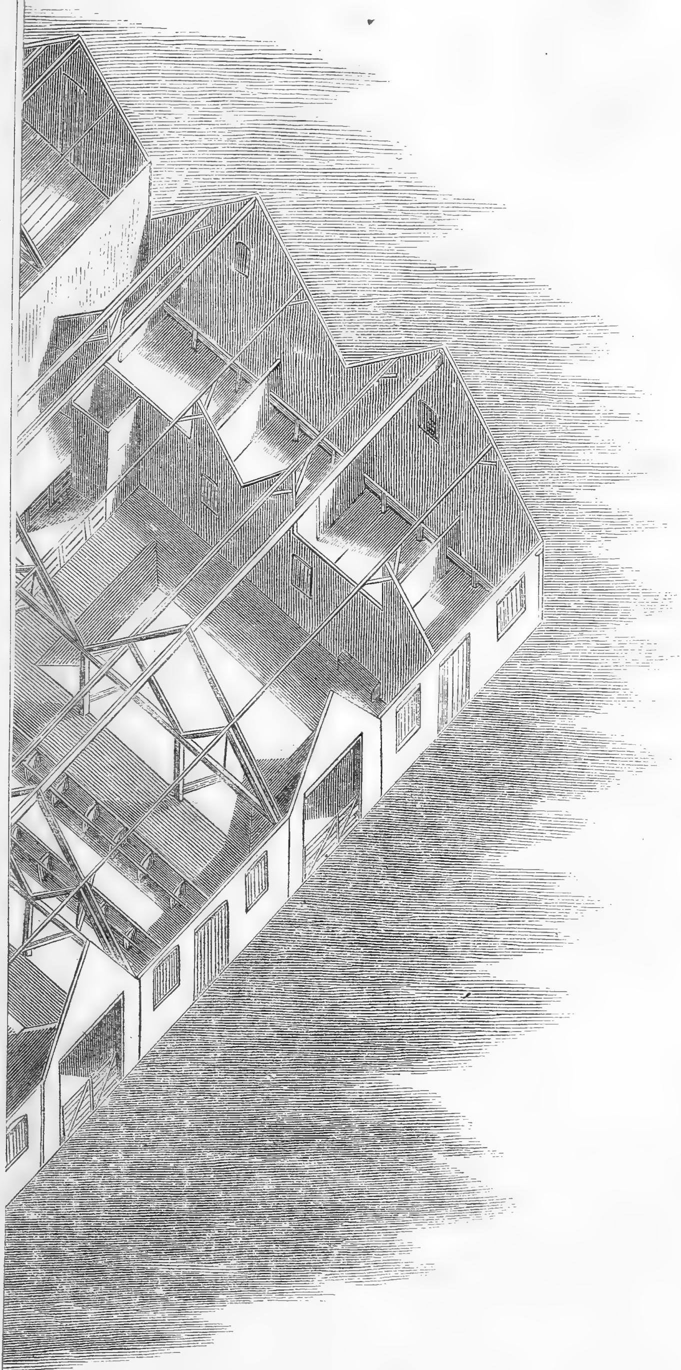
SECOND RETURN, 3rd December, 1853.

Districts.	Wheat.			Barley.			Oats.			Beans and Peas.			Turnip Seed.			Turnips.			Potatoes.			Mangold.			Carrots.		
	Qrs.	Bush.	Pecks.	Qrs.	Bush.	Pecks.	Qrs.	Bush.	Pecks.	Qrs.	Bush.	Pecks.	Qrs.	Bush.	Pecks.	Tons.	Cwts.	Qrs.	Tons.	Cwts.	Qrs.	Tons.	Cwts.	Qrs.	Tons.	Cwts.	Qrs.
1	8,218	0	0	16,074	0	0	20,934	2	0	2,342	0	0	18	3	0	43,406	0	0	3,122	0	0	59	10	0	0	0	0
2	6,142	4	0	11,527	6	0	14,670	6	0	1,647	6	0	45	7	2	31,084	5	0	1,578	15	0	.	.	.	24	0	0
3	7,336	6	0	11,067	6	0	12,249	2	0	2,445	2	0	56	7	0	24,283	10	0	5,296	3	0	118	10	0	446	0	0
4	12,227	6	0	13,775	0	0	17,442	0	0	3,715	0	0	36	2	0	*36,419	0	0	5,876	10	0	270	0	0	716	0	0
5	9,605	1	2	8,490	3	2	16,729	4	0	3,499	3	1	19	1	0	36,258	0	0	4,176	5	0	127	10	0	90	0	0
6	6,811	4	0	6,145	0	0	12,797	4	0	3,085	0	0	30	0	0	31,704	0	0	3,927	0	0	44	0	0	102	0	0
	50,341	5	2	67,079	7	2	94,823	2	0	16,734	3	1	206	4	2	203,154	15	0	23,976	13	0	619	10	0	1,378	0	0
Acreage	15,339⅜			12,809¾			16,802			4,809			157⅝			16,260			4,246¼			48½			107		
Average produce per acre	3	2	1	5	1	3½	5	5	$1\frac{1}{16}$	3	3	3⅓	1	2	$1\frac{11}{12}$	12	10	1⅓	5	12	3⅔	12	16	$3\frac{1}{7}$	12	17	2⅓

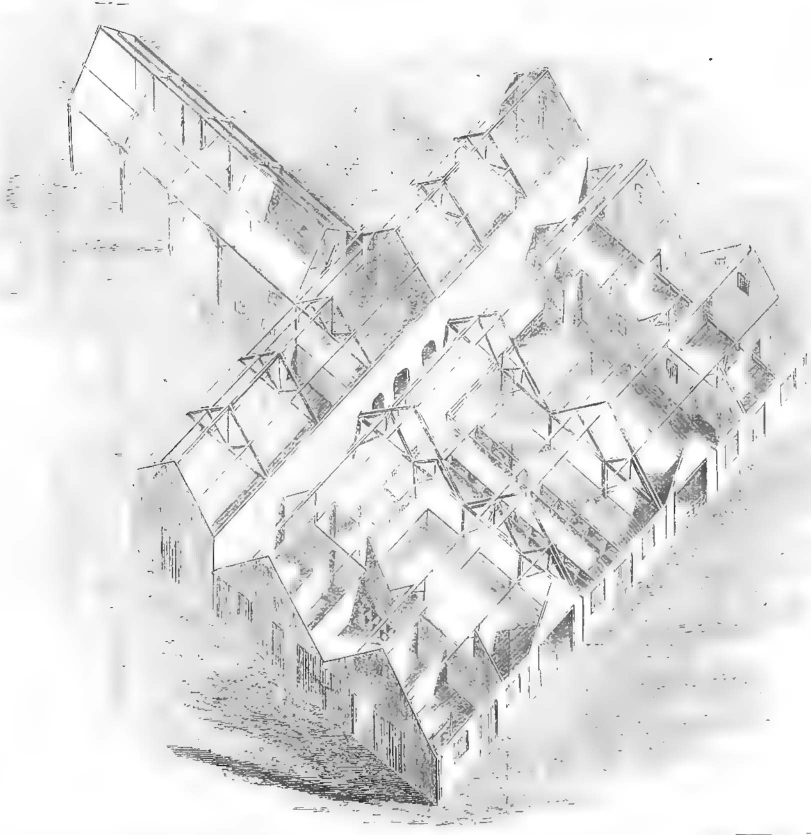
Districts.
No. 1. Parishes of Haddington, Gifford, Bolton, Morham, and Garvald.
No. 2. „ Pencaitland, Fala, Salton, Humbie, and Ormiston.
No. 3. „ Prestonpans, Tranent, and Gladsmuir.

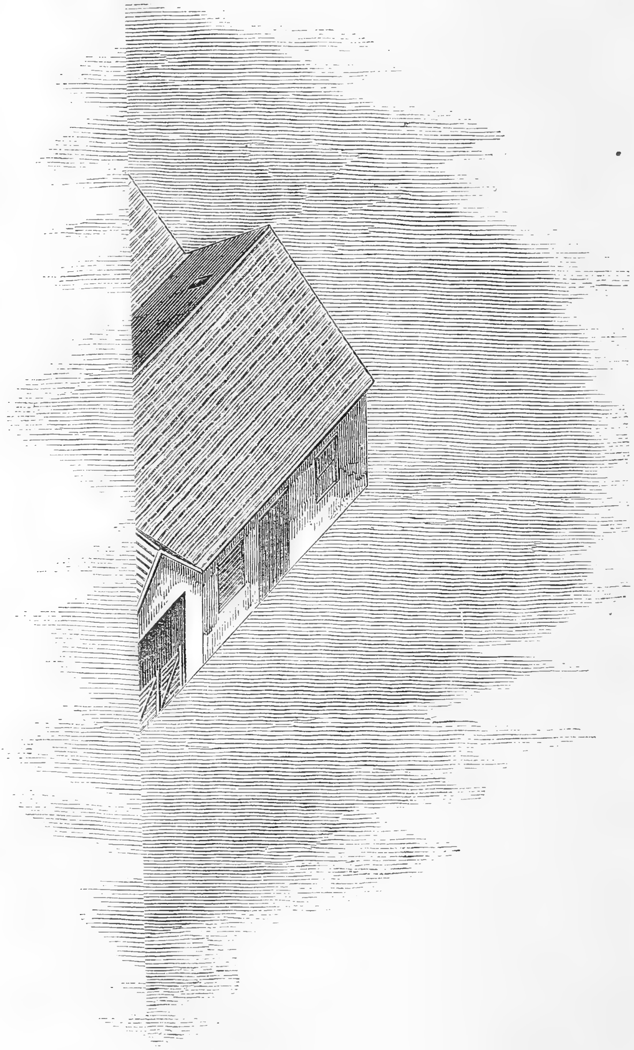
Districts.
No. 4. Parishes of North Berwick, Aberlady, Athelstaneford, and Dirleton.
No. 5. „ Prestonkirk, Whittingham, and Whitekirk.
No. 6. „ Dunbar, Innerwick, Spott, and Oldhamstocks.

* In multiplying the Acreage by the average of District No. 4, allowance has been made for 30 Acres returned as Turnips, but subsequently bare fallowed.



COVERED HOMESTALLS





0 10 20 30 40 50

SCALE, 20 FEET TO AN INCH.

XXI.—*On Covered Homestalls.* From W. Fisher Hobbs.

To the President.

My dear Sir,—Although we have published in our Journals several plans of farm-buildings within the last few years, yet I believe we have not noticed the "covered homestalls" which are by some approved of, and combine several advantages over those generally in use. At your request, I have enclosed with this letter a ground-plan and specification of a covered homestall, together with isometrical drawings showing the exterior elevation and internal arrangements of the same. This plan is suited to an occupation of 300 acres (two-thirds arable and one-third grass), and has lately been built at the Knapp Farm, near Ledbury, a short distance from the Gloucester and Hereford turnpike-road, on the estate of the Earl Somers, and which, for cost of erection, general arrangement, regulation of temperature, and style of building, is, in my humble opinion, worthy of the consideration of landed proprietors and others who are concerned in the improvement of estates, or take an interest in increasing the production of the soil.

I do not hold myself responsible for the estimates sent: they are drawn up by an able architect, Mr. Day, of Worcester, who has erected several covered homestalls upon the Eastnor estate and in the neighbourhood; and, from what I can ascertain, I believe his calculations are quite correct. For the purpose of comparison, Mr. Day has supplied me with specifications for ordinary farm-buildings, adapted for a farm of the same size. According to those calculations, it appears that a saving of fully 10 per cent. would be effected by the erection of covered homestalls instead of farm-buildings of the ordinary character, besides having almost the entire control over the temperature of the yards, which is of greater importance to the comfort and well-doing of the animals, and in the economy of their food, than we generally imagine.

The barn and granary are covered with a roof close boarded and tiled, but the yards, stables, &c., are covered with the Bridgewater roof-tiles, one of which is represented on the following page. These are, in my opinion, peculiarly adapted to the purpose. They are 14 inches square, and, when fixed, lap over 2 inches; consequently, 100 of them make 100 square feet of tiling. Each one (although a perfect security against rain or snow) acts as a ventilator, and therefore there is not that direct draft or current of air which is so objectionable where it only escapes through the sides or ends of buildings. This gradual

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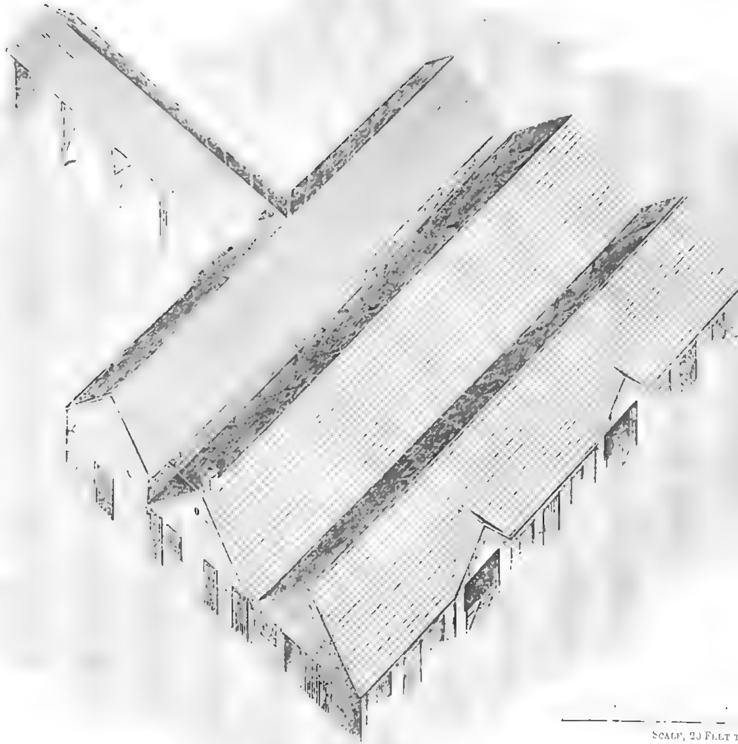
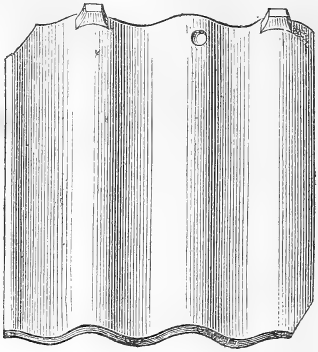


SCALE, 20 FEET TO AN INCH.

ventilation prevents that accumulation of ammoniacal vapours which is so common in ordinary farm-buildings where animals are kept. Some other advantages which covered homestalls



possess are the convertibility of the yards into divisions adapted to different purposes at the several seasons of the year, or to the particular requirements of the occupier, as well as the saving of the expense of making liquid-manure tanks, and the superior quality of the manure in the covered yards to that of ordinary manure made in open yards.

The arrangements for the threshing are for a portable steam-engine and threshing-machine, but a fixed engine and barn-works can be put up when desirable. Whatever merit there may be in this particular plan for a covered homestall, it is mainly due to Mr. Oakley, the agent at Eastnor, under whose management several have been erected on the estate, of a superior character to any I have elsewhere seen.

I remain, dear Sir, yours truly,

WM. FISHER HOBBS.

Boxted Lodge, Colchester, May 26, 1853.

Quantities of Work in the Erection of Homestalls with Open Yards.

Excavator, Bricklayer, and Tiler.

ft. in.		£. s. d.
	442 cubic yds. excavating for tanks, trenches for walls, and dishing out yards	
	43 rods 206 ft. supl. reduced brickwork . .	
196 0 run	Beam filling to 14-in. walls	
316 0	Ditto 9 ditto	
	Excavating and putting in No. 16 ketch pits, 9 in. square in the clear and 2 ft. deep, cemented .	
	230 yds. run rain-water drains, and excavating .	
	80 ditto liquid manure ditto . . .	
251 0 supl.	Reduced brickwork to liquid manure tank . .	
	Rough stone on top with ring	
194 4 supl.	$\frac{1}{2}$-brick in cement to wash-tank	
	18 yds. supl. cementing to ditto	
402 0 run	Cutting to gables	
	$46\frac{1}{2}$ yds. supl. builder bricks, flat in sand and grouted	
	665 ditto strong pitching in sand and grouted.	
88 0 run	Brick gutter	
	Levelling and ramming ground to the whole of the floors and pitching.	
	No. 5 9-in. and 1 6-in. iron grids pierced . .	
	53 yds. run second size drainers, double . .	
179 0 run	Brick on edge, coping in cement	
	No. 21 4-ft. and 3 6-ft. brick on edge sills in cement	
	98 sqrs. 92 ft. patent pan-tiling	
436 0 run	Cress with lap-joint	
117 0 ,,	Cutting to valleys	
	117 yds. supl. lath and 2 coat plastering to ceilings	
	£	577 17 7

Stone Mason.

		£. s. d.
	No. 4 plinths 14×14×14 under uprights holed for dowels	
	No. 2 pairs plinths $19\times14\times6\frac{1}{2}$ to barn-door cases holed for dowels	
	No. 23 ditto $19\times9\times6\frac{1}{2}$ holed for dowels .	
	No. 16 stone or slate covers for ketch pits with ring	
32 9 cube	Forest or Cradley stone tooled steps . . .	
22 6 supl.	Landing	
	Cutting No. 14 holes for balusters and run with lead	
20 0 run	$1\frac{1}{2}\times\frac{1}{2}$ in. iron handrail and fixing . . .	
	No. 14 balusters $\frac{3}{4}\times\frac{3}{4}\times2$ ft. 10 long . . .	
204 0 supl.	1-in. slate bottoms to mangers grooved for divisions and joints cemented	
	No. 2 slate troughs 45 gallons each, put together with red and white lead, with iron rods nutted and screwed	
	No. 5 small ditto in mangers of cow-house . .	
	No. 4 stone plinths 9×9×9 under stall-posts holed for dowels	
270 0 supl.	2-in. barn-floor tooled	
	£	48 7 4

Carpenter and Joiner.

ft.	in.		£.	s.	d.
		Template for wash-tank, 30 ft. supl. sheeting, and centreing for ditto			
		Use and waste of centreing for No. 38 openings, including No. 4 6-ft. openings			
990	0 cube	Timber in roofs			
254	4 supl.	$1\frac{1}{4}$-in. ridge			
156	0 ,,	$\frac{3}{4}$-in. valley boards			
341	9 ,,	1 in. chamfered fascia			
124	6 ,,	1-in. chamfered and rounded barge-boards			
166	0 run	$2 \times 1\frac{1}{4}$ rounded fillets for tiles			
		Iron-work to roofs			
16	10 cube	Oak chamfered uprights to cart-shed			
26	5 ,,	Fir breastsummer smoothed one side			
18	10 ,,	Girders			
148	4 ,,	Granary floor-joist and plates, &c.			
		7 sqrs. 20 ft. $1\frac{1}{4}$ in. red deal batten floor tongued with hoop iron, bradded, punched, and puttied			
		3 sqrs. 32 ft. supl. 1-in. tongued floor			
		1 sqr. 28 ft. supl. 1-in. rough-boarded floor			
		No. 1 step-ladder to gain access to loft over hackney-stable and gig-house			
6	11 cube	Oak curb on dwarf walls to barn			
157	6 ,,	1-in. boarding inside granary			
166	8 ,,	Framing to weather-boarding and calf-pens			
1064	6 supl.	1-in. rough weather boarding to barn, &c.			
64	0 ,,	Rough boarding and framing to chaff-bin			
		Extra labour to door in ditto and hinges, latch			
16	0 ,,	Bottom and bearers to ditto			
383	0 ,,	1-in. boarding to calf-pens			
32	0 run	Troughs to ditto			
13	4 cube	Sleepers under lattice-floor			
468	0 supl.	Lattice-floors part made moveable			
		No. 2 barn-doors and cases with sills to ditto in two heights, with wicket door			
		No. 1 gig-house door and case complete with iron bars and wheels			
		No. 2 doors and cases with centre boards to stable in two heights, 2-in. framed, braced, ledged, ploughed, tongued, and beaded			
		No. 16 ditto and ditto, 1-in. ledged, ploughed, tongued, and beaded			
		No. 4 ditto and ditto, 1-in. ledged doors			
		No. 3 luffers and frames complete with iron centres, laths, and oak sills to granary			
		No. 1 frame with oak sill and centre boards prepared for glass			
		No. 9 frame with oak sills and centre boards filled in with upright bars and sliding frames			
		No. 3 frame with oak sills and centre boards, one half filled in with uprights and sliding frames, the other with 2-in. lights prepared for glass			
		No. 2 lids and frames with oak sills and centre boards			
		No. 2 double frames with mullion in centre, filled in with 1-in. uprights and sliding frames in piggery			
		No. 4 8-ft. framed and braced gates complete, and posts to ditto, with braces underground			
15	0 run	Post and rail fencing to cattle boxes			

ft.	in.		£	s.	d.
31	0 run	Posts, rails, and rounded on top pales to piggery $3\frac{1}{2}$ ft. high			
80	0 ,,	Of mangers for cows with No. 30 posts and bearers, and 20 shackling irons with rings . . .			
48	0 ,,	Ditto in cart-horse stable			
		No. 3 stall posts and partitions			
12	0 ,,	Of manger in hackney stable			
		No. 1 wood stall post and rails, filled in with $1\frac{1}{2}$-in. boards			
		Nest-boxes in poultry-house, hatch, roost poles, and ladder			
		No. 6 oak frames for grids in stables . . .			
21	0 ,,	Of oak curb to slate troughs in cattle yards . .			
		No. 2 saddle and 4 harness pegs			
		No. 8 collar and 8 ditto in cart-horse stable			
		Getting out the ground to the whole of the posts, about 60			
13	0 cube	Oak sill top of sleeper walls to receive posts . .			
		Fastenings, 4 pairs strong hinges to gates, 22 pairs hook and eye hinges to doors, and 1 pair ditto to shutter			
		£	480	19	0

Plumber, Painter, and Glazier.

ft.	in.		£.	s.	d.
		12 cwt. 3 qrs. 7 lbs. lead to roofs.			
756	0 run	4-in. cast-iron eaves, spouting fixed and painted .			
171	0 ,,	$2\frac{1}{2}$-in. down pipes			
		No. 16 heads and 16 shoes			
		$384\frac{1}{3}$ yds. supl. 3 coats in oil			
		Painting iron handrail and balusters, 2 coats .			
27	3 supl.	16 oz. sheet-glass in putty			
		Pump to liquid manure tank			
		£	59	13	0

Summary.

	£.	s.	d.
Excavator, bricklayer, and tiler .	577	17	7
Stonemason	48	7	4
Carpenter and joiner . . .	480	19	0
Plumber, painter, and glazier . .	59	13	0
	£1166	16	11

Henry Day,
Architect and Surveyor,
Worcester.

December, 1852.

Quantities of Work in the Erection of Covered Homestall.

Excavator, Bricklayer, and Tiler.

ft.	in.		£	s.	d.
		334 cubic yds. excavating trenches for walls and dishing out yards			
		29 rods 99 ft. reduced brickwork			
		Excavating and putting in No. 11 ketch pits, 9 ins. square, and 2 ft. deep, cemented			
		150 yds. run rain-water drains, and excavating			
194	4 supl.	½ brick in cement to wash-tank			
		18 yds. supl. cementing to ditto			
366	0 run	Cutting to gables			
		44¾ yds. supl. builder brick flat in sand, and grouted			
		338 ditto strong pitching in sand, and well grouted			
50	0 run	Brick gutter			
		Levelling and ramming the ground to the whole of the floors, and pitching 382 yds.			
		No. 5 9-inch (½ inch) iron grids pierced			
		No. 1 6-inch ditto			
		23 yds. run second-size drainers double			
		Providing and fixing No. 2 iron air-bricks			
		No. 12 4-ft. brick on edge sills in cement, and No. 1 6-ft. ditto			
		115 sqrs. 9-ft. supl. patent pan-tiling			
396	0 run	Cress with lap-joint			
108	0 ,,	Cutting to valleys			
		112 yds. supl. lath and 2-coat plastering to ceilings			
		£	422	17	2

Stonemason.

ft.	in.		£	s.	d.
		No. 20 Forest stone plinths under uprights 14×14 ×14 holed for dowels			
		No. 13 pairs plinth stones 19 × 9 × 6½ holed for dowels			
		No. 11 slate or stone covers to ketch-pits 1 ft. 6 in. square, with ring			
32	9 cube	Forest or Cradley stone tooled granary steps			
22	6 supl.	Landing			
		Cutting 14 holes for balusters and run with lead			
20	0 run	1½ by ½-inch iron handrail and fixing			
		14 balusters 2 ft. 10 in. long ¾ × ¾			
204	0 supl.	1-in. slate bottoms of mangers grooved for divisions, and joints cemented			
208	0 ,,	1-in. slate bottoms of gutters grooved for sides and joints tongued and screwed to bearers			
156	0 ,,	½-in. sides put together with oil cement			
		2 slate troughs, 45 galls. each, put together with red and white lead, with iron rods nutted and screwed			
		No. 4 stone plinths 9 × 9 × 9 under stall-posts in cart-horse stable			
		£	47	2	8

Carpenter and Joiner.

ft.	in.	
		Template for wash-tank, 30 ft. supl.; sheeting and centreing to ditto . . . .
		Use and waste of centreing No. 33 openings, including No. 2 10-ft. ditto . . . . .
		1150 ft. cube timber in roofs . . . . .
231	0 supl.	$1\frac{1}{4}$-in. ridge board . . . .
144	0 ,,	$\frac{3}{4}$-in.- valley boards . . . . . .
243	3 ,,	1-in. chamfered fascias . . . . . .
187	0 ,,	1-in. ditto and rounded barge boards .
254	6 run	2 × $1\frac{1}{4}$-in. rounded fillets for tiles . . . .
		No. 9 skylights and frames with gutter-boards and bearers at back . . . .
		Grooving sides of gutter-beams for slate gutters, 315 ft. run . . . .
		Iron work to roofs . . . .
87	6 cube.	Oak chamfered uprights to yards, driving way, &c.
23	10 ,,	Fir breastsummer, smoothed one side . . . .
18	10 ,,	Girders . . . .
186	10 ,,	Granary floor joist, &c. . . . . . .
61	0 ,,	Oak floor joist to barn and sleepers . . . .
		15 sqrs. 70 ft. $1\frac{1}{4}$-in. red deal batten floor, tongued with hoop-iron, bradded, punched, and puttied with 2 ledged lids in ditto . . . . .
		3 sqrs. 32 ft. supl. 1-in. floor tongued . . . .
100	0 supl.	Rebated boarding to hoist, and 3 ft. 9 in. of framing to ditto . . . .
143	6 ,,	1-in. boarding inside granary . . . . .
130	4 cube	Framing for weather-boarding and boarding to calf-pens . . . .
540	9 supl.	1-in. rough weather-boarding to barn, &c. . .
490	0 ,,	Lapped boarding to calf-pen, 1 in. on one edge, and $\frac{1}{2}$ in. on the other . . . .
192	0 ,,	1-in. boarding inside calf-pen . . . . . .
36	0 run	Troughs . . . .
12	0 cube	Old oak sleepers under lattice floors . . . .
380	0 supl.	Lattice-floors, part made moveable . . . .
		4 sliding shutters in boarding for supplying troughs
		2 ditto in doors for ventilation . .
		No. 1 gig-house door and case complete, door to slide with iron bars and wheels . . . .
		No. 1 door and case, with centre-boards to stable .
		2-in. framed, braced, ledged, ploughed, tongued and beaded in two heights . . . . . .
		No. 13 ditto and ditto 1-in. ledged, ploughed, tongued, and beaded . . . . . .
		No. 1 pair folding-doors 1-in. ledged to threshing-floor, with 3 uprights . . . . . .
		No. 3 doors 1-in. ledged to ditto and calf-pens .
		No. 3 window deal frames in corn-barn with oak sill and 2-inch lights, one half to slide . .
		No. 5 luffers and frames complete with iron centres and laths, with centre boards to No. 2 and oak sill . . . .
		No. 7 frames with oak sills and centre boards filled in with upright bars and sliding frames 3 feet square in clear . . . .
		No. 4 lids and frames and centre boards, 1-in. ledged and beaded lid . . . .
		No. 3 frames with oak sills and centre boards, one half filled in with uprights and sliding frames, the other with 2-inch lights prepared for glass $3\frac{1}{2}$ ft. square . . . .

ft.	in.		£ s. d.
		No. 2 8 ft. framed and braced gates complete, and posts to ditto, with braces under ground . .	
68	0 run	Post and rail fencing to cattle boxes . . .	
		Extra on No. 2 framed and braced gates to ditto .	
88	0 ,,	Posts and rails with rounded on top pales to piggery	
		Extra on No. 4 framed and paled gates to ditto .	
80	0 ,,	Of mangers for cows, with 40 posts and 20 shackling irons with rings	
48	0 ,,	Ditto in cart-horse stable	
		No. 3 stall wood posts and partitions filled in with $1\frac{1}{2}$-in. boards	
		No. 1 partition, with door in cart-horse stable, for chaff, &c., 18 ft. × 6 ft., including door . .	
12	0 ,,	Of manger in hack stable	
		No. 1 stall wood post rails, and filled in with $1\frac{1}{2}$-in. boards, hack stable	
		Nest-boxes in poultry-house, hatch, roost poles, and ladder	
		No. 6 oak frames for grids in stables . . .	
21	0 ,,	Of oak curb to slate troughs in yards . . .	
69	9 supl.	Rough boarding and uprights in chaff-bin, 5 ft. 7 in. cube framing	
		No. 3 step-ladders in root house, corn barn, and hack stable	
		No. 2 saddle and 4 harness pegs	
		No. 8 collar and 8 harness pegs in cart-horse stable	
		No. 1 gate to root-house with posts, gate framed and paled 3 ft. × 3 ft. 6 in.	
		Getting out ground to the whole of the posts, about 70	
36	0 cube	Sill top of sleeper walls to receive posts . .	
		Fastenings	
		20 pairs hook-and-eye hinges to doors, 7 to gates, 2 strong ditto	
		3 ditto to shutters, 2 pairs T hinges to lids in floor	
		£	530 17 7

Plumber, Painter, and Glazier.

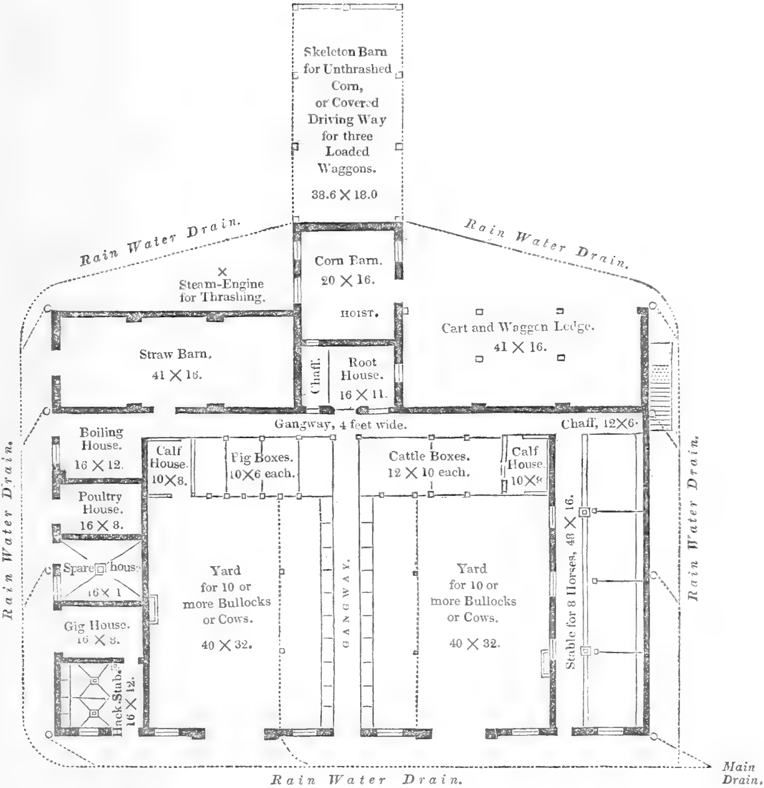
ft.	in.		£ s. d.
		19 cwt. 1 qr. 10 lbs. lead, valleys, flashings, &c. .	
261	0 run	4-in. cast-iron eaves spouting, fixed and painted .	
134	0 ,,	$2\frac{1}{2}$ in. down pipes, 11 heads and 11 shoes ditto .	
		267 yards supl. 3 coats in oil	
		55 ditto 2 ditto	
		Painting iron handrail and balusters, 2 coats .	
55	1 supl.	16 oz. sheet-glass	
91	1 ,,	21 oz. ditto in skylights	
		£	51 17 11

Summary.

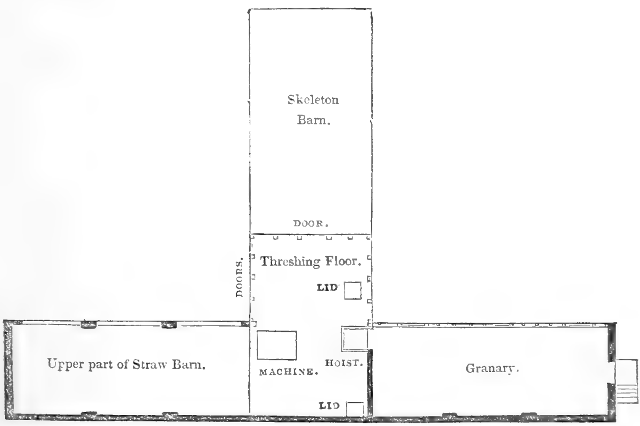
	£.	s.	d.
Excavator, bricklayer, and tiler .	422	17	2
Stonemason	47	2	8
Carpenter and joiner . . .	530	17	7
Plumber, painter, and glazier . .	51	17	11
	£1052	15	4

HENRY DAY,
Architect and Surveyor,
Worcester.

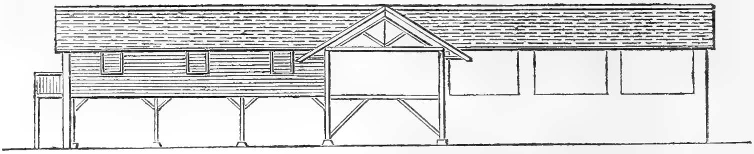
December, 1852.



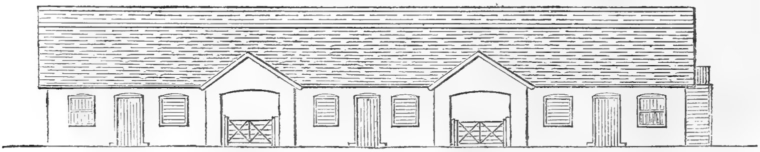
GROUND PLAN.



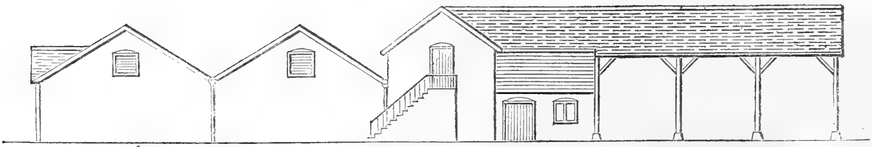
PLAN OF TWO-STORY BUILDING.



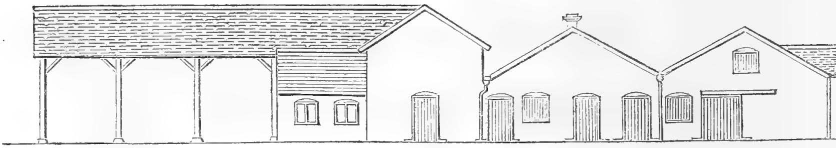
NORTH ELEVATION.



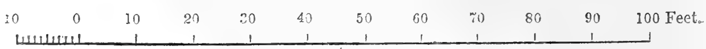
SOUTH ELEVATION.

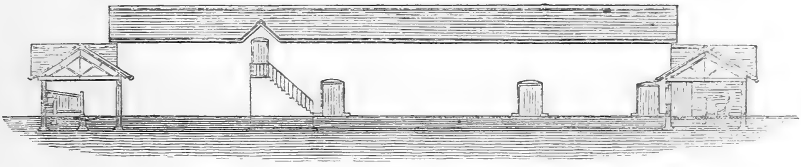


EAST ELEVATION.

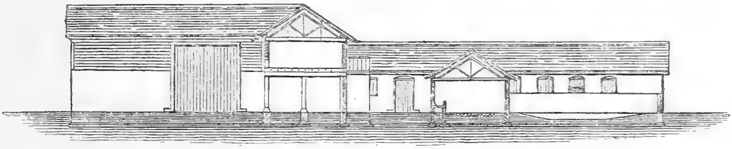


WEST ELEVATION.

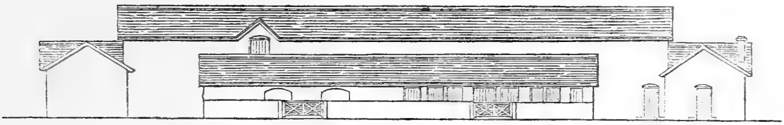




SECTION ON THE LINE AB.

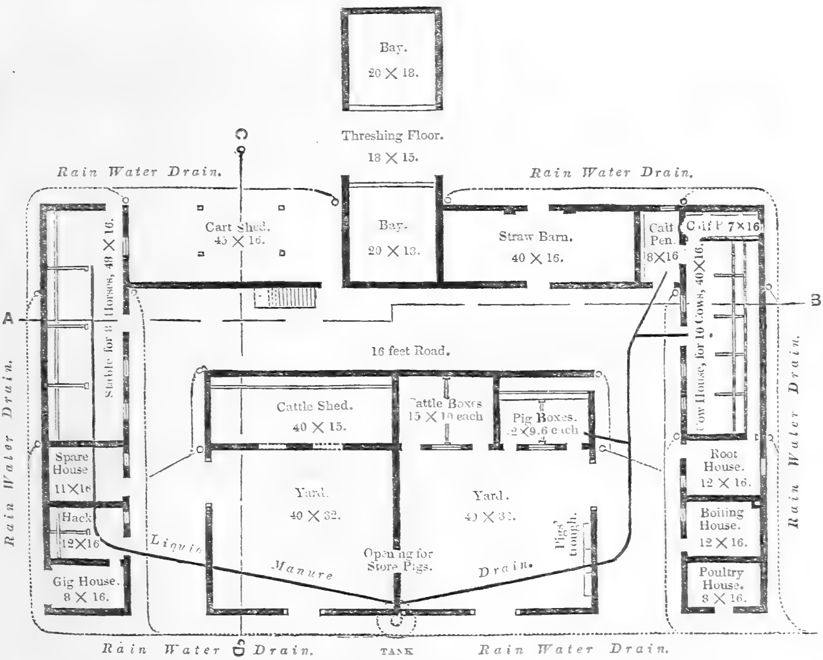


SECTION ON THE LINE CD.



FRONT ELEVATION.

PLAN AND ELEVATIONS OF FARM STEADING WITH OPEN YARDS.



GROUND PLAN.

XXII.—*On Covered Farm-Steadings.* From Lord Kinnaird.

To the President.

Dear Sir,—You may perhaps remember, in the year 1851, I sent for insertion in the Journal a plan of farm-buildings which I had lately erected on my property. Having since that time had an opportunity of testing its merits, I now wish to lay before you a plan somewhat similar in construction, but containing the improvements which experience has shown to be advantageous. Having derived great benefit myself, and effected much economy in the working of my farm, by the adoption of the system, if I may so call it, laid down in the accompanying plan, I send a copy of it, in the hope that it may prove useful to farmers and proprietors in England. I consider a convenient homestead or steading as essential for the economical, and therefore profitable, working of a farm; and, for this end, compactness in its internal arrangements is indispensable, but has not hitherto been sufficiently appreciated either by the farmer or architect. Detached buildings, with large and small courts—outer and inner courts, extending over a considerable area of ground—expensive in original construction and entailing a daily waste of labour, farm produce, and time, consumed in traversing from one yard to another—are faults which I have found in most farm-buildings I have visited, and have tried to avoid in the plan sent herewith; which, in consequence of the arrangement of the different compartments, enables 100 cattle to be fed with greater ease by one man than the 30 usually allotted to him, with the personal convenience of being at all seasons under shelter. A steading, entirely covered in, effects a great saving in farm produce, which must otherwise be exposed to the injurious effects of the weather, while the amount consumed and destroyed by the stock is considerably less; but the most remarkable result of my experience is in the value of the manure.

In October, 1850, the yards were filled with 14 feeding bullocks, getting the same quality of food as another lot of 18, tied up in the byre, and whose manure was put out into an open court. In the open court were 12 young animals, getting a full allowance of turnips. The feeding beasts were all of the same age—viz. 2 off and rising 3 years old; fed twice a-day on turnips, of which each got about 1 cwt., and once a-day on steamed swedes mixed with cut chaff, and 2 lbs. of barleymeal mixed with a little linseed, or 3 to 4 lbs. of oilcake—of this mess each got 22 lbs. Both byres and courts were littered twice a-day; and, as near as we could judge, each animal got the same allowance of straw, and all had a constant supply of oat-straw in their

racks. From the foregoing particulars it will be seen that the manure thus made should have been about equal.

During the winter of 1850-1 the manure in the open yard was carted to the field selected for the experiment, and put in one large heap of 200 loads, well pressed down by the carts driving over it when emptying, and then covered top and sides with earth and road-scrapings. It lay thus till a week before using, when it got a turn over in the usual way. The dung in the covered yard had been allowed to collect all winter, was carried direct to the field, and put into the drills, without any turnings, being quite well enough *made* for the crops intended.

A field of 20 acres, of very equal quality, being a rich loam lying on the trap, naturally dry, and in good heart, exposed to the south at an elevation of from 80 to 100 feet above the sea, was selected for the experiment, and divided into two equal portions. The manure applied was at the rate of 20 cart-loads per acre. The whole field was planted with potatoes; the seed all of one kind, from one field (Regents); planted first and part of second week of April. All brairded well, and showed no difference in growth till the first week of July, when a decided superiority began to manifest itself in the half of the field manured out of the covered yards. The shaws on the portion of the field manured by the dung from the open courts began to decay by the latter end of July, and by the second week in August were nearly all gone; whilst the other portion of the field still retained its strong dark green. The crops were taken up on the 1st to 4th of October, after two separate portions in each half had been carefully measured and weighed, the result being as follows. I may mention that disease showed itself more especially in the heavy crop.

Uncovered Dung.

	Tons.	cwt.	lbs.	
1st measurement.—1 acre produced . . .	7	6	8	of potatoes.
2nd measurement.—1 acre produced . . .	7	18	99	of potatoes.

Covered Dung.

	Tons.	cwt.	lbs.	
1st measurement.—1 acre produced . . .	11	17	56	of potatoes.
2nd measurement.—1 acre produced . . .	11	12	26	of potatoes.

As soon as possible after the potatoes were lifted, the field was cleaned, ploughed, and (on the 22nd to 25th of October) Fenton wheat was drilled in, at the rate of 3 bushels per acre. The same portions of each half measured in the potato experiment were marked off for trial with wheat. As soon as the weather suited in spring the whole field got a dressing of 3 cwt. of Peruvian guano per acre. During the winter very little

difference was apparent; but, shortly after the application of the guano, the crop on that portion manured by the covered dung took a decided lead, which it retained all summer. The whole field was cut the 26th of August, 1852; the portion manured by the uncovered dung being at least 4 days earlier than the other. As before, the two separate portions in each half of the field were measured, cut, and stooked, separately; on the 4th of September each portion was thrashed, the grain carefully measured, and the straw weighed. The weather having been rather wet, the grain was soft, and not in good order: this will account for the light weight per bushel. The light crop beat the heavy crop in quality by ½ lb. per bushel.

Wheat on Uncovered Dung.

Acre.	Produce in Grain. Bush.	lbs.	Weight per Bush. lbs.	Produce in Straw. Stones.	lbs.
1st.	41	19	61½	152	of 22
2nd.	42	38	61½	160	„

Wheat on Covered Dung.

Acre.	Produce in Grain. Bush.	lbs.	Weight per Bush. lbs.	Produce in Straw. Stones.	lbs.
1st.	55	5	61	220	of 22
2nd.	53	47	61	210	„

I have thus shown what I consider to be the advantage derived from having the whole building under cover, and the importance of compactness in the construction thereof. I now proceed shortly to explain some of the details of the internal arrangement.

I begin with the steam-engine. There is no doubt such a power, where an abundant supply of water cannot be obtained, is of great value, and owing to railways there are few places where coals cannot now be procured, so as to render it advantageous to employ steam in connection with farm-buildings. I believe it to be still a disputed point whether it is of most advantage to have a moveable or fixed engine. When a man has two or more farms situated at a distance from each other, a moveable engine may be of advantage; but when this is not the case there can, I think, be no doubt that a fixed one is preferable. The question next arises as to the size of the engine. Considerable power, say 6 or 8-horse, is required to thrash and dress grain for the market, but there are few farms where it will pay to keep this sized engine constantly at work; and yet, properly speaking, there is not a day during 6 or 7 months of the year when the motive power is not required. This subject has given me much consideration; and I have come to the conclusion that it is better and cheaper to have 2 small engines of, say 3 or 4-horse power each, than 1 large one; the cost of the smaller engine is from

60*l.* to 75*l.*—thus the 2 do not exceed, or even amount to the expense of 1 large one. I am confirmed in this opinion from hearing that, in a large factory, the owner has adopted the system of having several small engines instead of 1 or 2 large ones, saving thereby in erecting the machinery a great amount of heavy shafting, and also considerable expense in the daily working. A farmer would only require to work his 2 engines when thrashing grain, while 1 of them would do all he need on other days, and be kept constantly going. I find that a small engine in daily use consumes only $2\frac{3}{4}$ cwt. of Scotch coals per day, which can be procured here at about 8*s.* per ton; so that, including oil and repairs, the cost may be taken at 1*s.* 6*d.* per day. The man in charge attends also at the same time to the following machines:—

1st. A turnip-washer, from which the turnips are taken by elevators to the cutters, falling, when cut, into the tubs and waggons ready, when mixed with the chaff, &c., to be conveyed away to the stock.

2nd. Chaff-cutter.

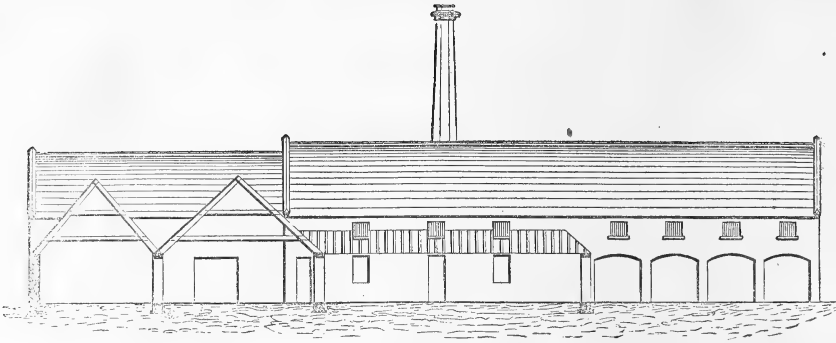
3rd. Corn-bruising machine.

4th. Cake-crusher.

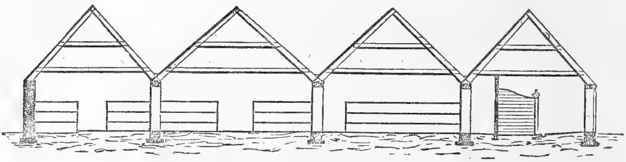
5th. Pair of mill-stones.

The prepared food from the 3 last machines falls into a store, the key of which is kept by the farmer; the steam from the engine is employed to heat a kiln for drying grain, heating water, and steaming food for horses and pigs. The only assistance the man who attends to the engine has is that of a woman, who supplies the turnip-washer with turnips, and who besides feeds and has the charge of a hundred sheep on boards. This peculiar system of feeding is very profitable, particularly in such a season as the last, when I have been able since November to feed and sell off 3 different lots of sheep, leaving an amount of manure ready for my turnip crop equal to a good cargo of guano. The cattleman, having the food thus prepared to his hand, has nothing to do but to put it into the waggon, which, by means of a railway, is easily conveyed to all parts of the building, and thus enables him (as I before stated) to feed and superintend a hundred cattle, being saved the cleaning out of the stalls, which is required when cattle are tied by the head. Economy of labour is by this means effected, in addition to the advantage derived by the animals, as the less disturbed cattle are when feeding the better.

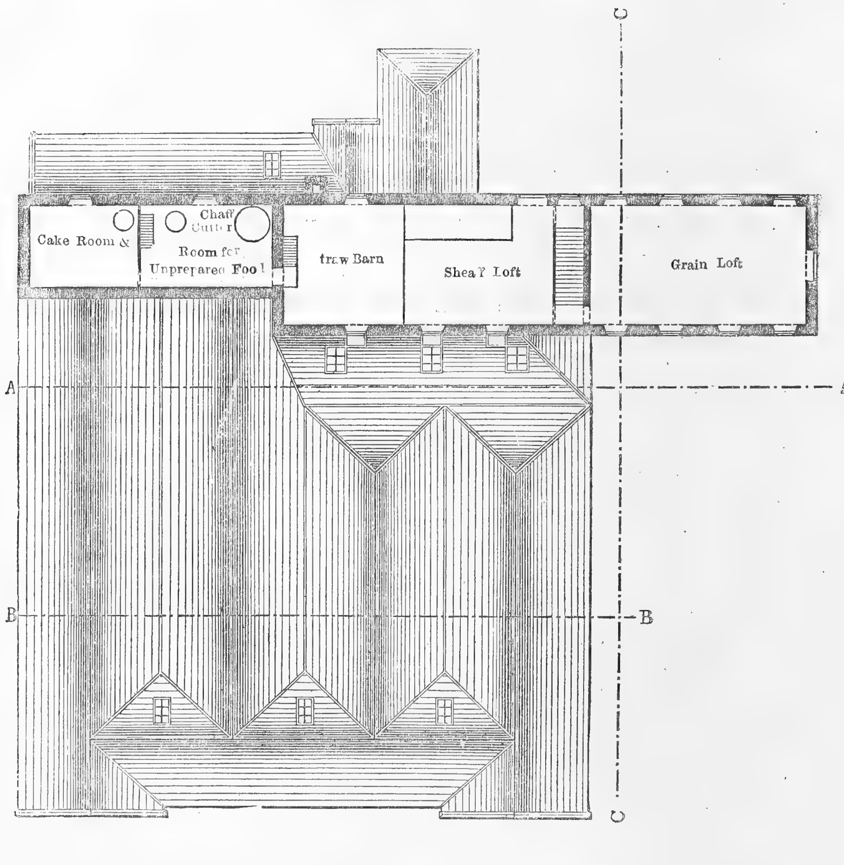
The boxes or courts are divided by round spars, or young larch trees, which I find answer best, being made to shift up and down by falling into cast-iron sockets. The boxes are sunk about $2\frac{1}{2}$ or 3 feet below the passage, and by means of the open-

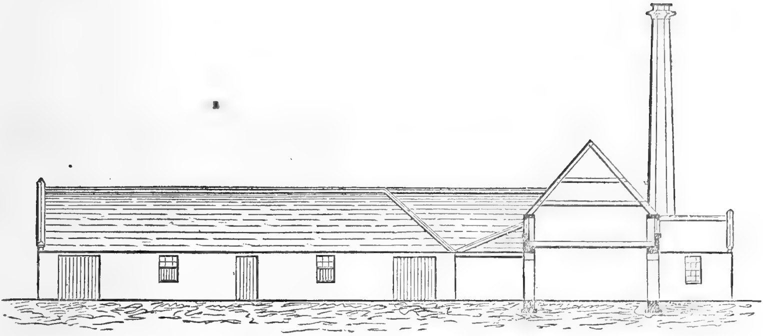


SECTION AND ELEVATION A.A.

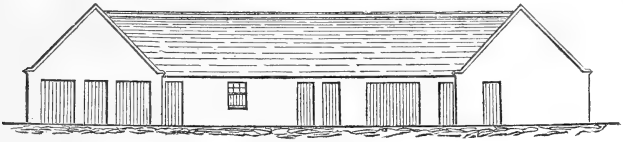


SECTION B.B.

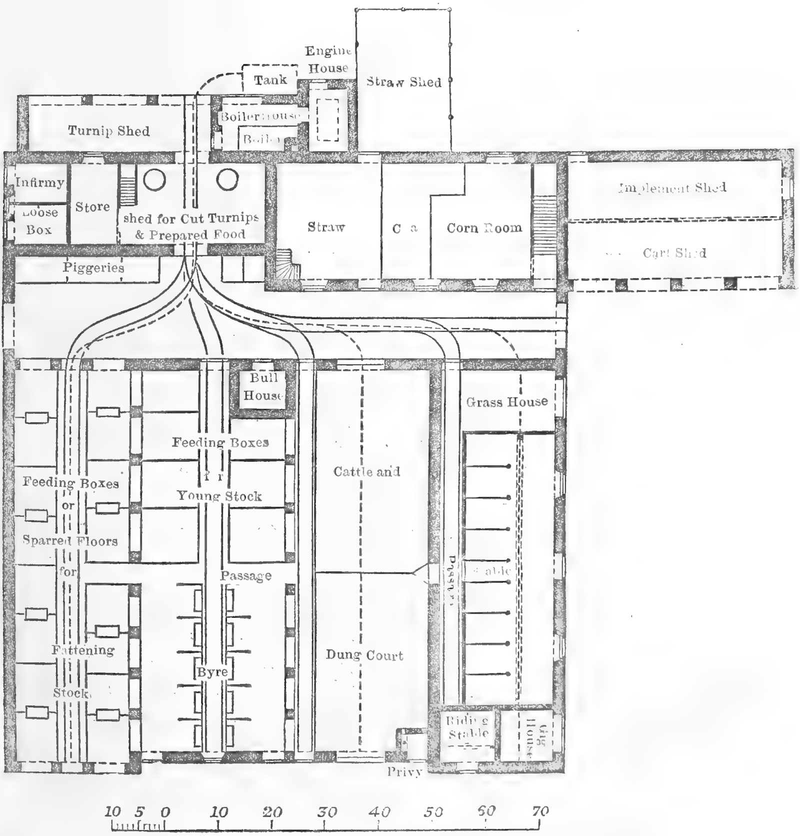




SECTION AND ELEVATION B.B.



FRONT ELEVATION.



ing at each end of the row of boxes they are emptied out with as great facility as carting from a common dung-heap. The feeding troughs are made to slide up and down as the dung accumulates; the cattle are supplied with water by means of troughs filled from a cistern with a ball-cock. My plan admits of either boxes, sparred floors, or stalls being adopted—a combination of both, particularly the two former, is preferable. The stalls being appropriated to the cows, not requiring straw when laid with tiles, and having a matting extending along the front of the stall.

The stable is not lofted, and the horses being fed at the head, the best ventilation is secured; indeed this is the case with the whole steading. The outside roofs are slated, while for the interior roofs, except the stable, pantiles are used. I have found roofs thus constructed give sufficient warmth in winter, combined with coolness and ventilation in summer. The drains, it will be seen, are all conducted into the tank to which the pump, worked by the engine, is attached, for the purpose of applying the liquid manure to the rye-grass and other green crops. The roofs running N. and S. have a slight inclination to the N., by which means very narrow gutters, requiring but a small amount of lead, answer every purpose, and the rain-water from the roof is collected for after application by the pumps. The doors are all made to slide, and are fastened on the inside by a chain and hook, with the exception of the principal entrance, which is at one gate between the stable and cart-shed, and which alone has a lock; the whole concern is by this means secured, on the same principle as that adopted in factories. Another advantage of the accompanying plan is, that it may be adapted to a farm of any dimensions, by merely extending or curtailing the length of the sheds running N. and S.

I have endeavoured, as concisely as I am able, to give an idea of the different conveniences of the steading, which will, I think, be understood by reference to the Plan. For the details and specifications, I would refer your readers to Mr. J. Scott, architect, Dundee, in whose hands I have placed them, and who will supply the necessary information to any party applying, at a very moderate charge.

I have already sent a copy of the plan to a weekly journal, the 'North British Agriculturist;' but as many English landowners may not see that publication, I think, if there be space in the Journal, the description of a plan, of which the effectual working is daily under my own eye, may be useful at a time when so much is needed and is doing towards the improvement of agricultural buildings in England.

There is no doubt that many, who are really anxious to im-

prove their estates, are deterred from so doing by the large outlay required for erecting buildings such as we in Scotland deem necessary; but as I have found that the steading, of which the above is the description, could be constructed, exclusive of machinery and carriage of materials, for 1000*l*., previous to the late rise in the value of labour and cost of materials, which may be estimated at 20 per cent., I thought these few explanatory remarks, and the accompanying plan, might not prove unacceptable to your readers. The details have not been laid down on any theoretical principle, but are the result of practical experience; and I have only to say, that the increased returns from my farm and reduction of expense since the adoption of this plan, afford me undeniable evidence of its efficacy.

Yours faithfully,

KINNAIRD.

XXIII.—*Judges' Report on the Exhibition of Implements at the Gloucester Meeting*, 1853. From Sir MATTHEW WHITE RIDLEY, Bart., Senior-Steward.

AT no time since the commencement of the Royal Agricultural Society of England, in 1839, have its proceedings been attended with greater success or usefulness than at the meeting lately held at Gloucester. The implement yard has been, as usual with visitors, the chief object of attraction, while the number of implements exhibited shows a marked increase on previous years. But it is not in numbers only the Gloucester meeting is remarkable. The mechanical intelligence of the country has been taxed to the utmost in the competition for the Society's premiums, and the result has been a collection of implements at once creditable and honourable to the manufacturers and exhibitors. The moral effect of such a combination of mechanical ingenuity concentrated on one particular spot is fully shown by the critical examination given to the different machines and implements, and by their utility or defects being continually pointed out. Many a useful and practical hint has been gathered by the manufacturers from the arguments and observations of visitors, who sometimes, however, condemn what they do not fully understand. At the same time such visitors are no less ready to point out for recommendation such machines or tools as they are practically acquainted with, and which may be with them in every-day use. Improvements are, however, continually made in the construction of agricultural machinery. That which twenty years ago was thought impossible has been attained; and such are the powers of invention and machinery, that the word *impossible* appears to vanish from the mechanical vocabulary.

Waggons.—In this class there were six exhibitors, the construction and the price of each waggon varying considerably. To build the best waggon for all general purposes requires much judgment, and it would be a task to point out what it should be. Wanted for all purposes, whether in the field or the road, to carry corn in the straw and corn out of the straw, a really useful waggon on a farm is most desirable. The waggon aimed at should be one that reduces as far as practicable the amount of labour required in loading, as well as the tractive power. For harvest purposes the waggons generally shown were too high on the body, giving the harvesters unnecessary toil in throwing up the corn. It is no question here, whether carts or waggons are most valuable in the harvest-field; the former would decidedly have the preference before the high waggons exhibited, some of which would create a mutiny in the harvest-field. It is the opinion of the judges (at least of one of them) that too much value is placed upon the plan of turning the fore-wheels under the waggon-body. To arrive at this, two evils have to be encountered—the high body before complained of, and the low fore-wheels used generally in waggons of this class. It happens most frequently that the fore-wheels carry the greater weight, and, having many more revolutions to make than the hind-wheels, there is a corresponding increase in the tractive power required. To meet this difficulty, Mr. Busby has constructed a waggon to carry nearly the entire load on the hind-wheels, the fore-wheels being useful more as a means of steerage to the machine, which looks like a four-wheeled cart rather than a waggon. The attempt to remove the load from low fore-wheels shows that the principle of draught is studied by the builder if it be not understood. Mr. Crosskill's waggon, being lower in the body and lower in price than some exhibited, was considered the best for general purposes, and received the Society's premium.

Carts.—The carts exhibited were upon the whole a better class of implements than the waggons, and the judges had some difficulty in determining which was the best. The contest lay between those who had copied the plan of Busby, for which he obtained well-earned premiums at Lewes and Exeter, and others who retained the horizontal traction and other advantages of this class of carts, but gave, without additional weight, more room in the body, and a reduced price. In this class the Society's premium of 5*l.* was awarded to Mr. Thomas Milford, of Thorverton, Devon, for his cheap and useful cart, containing no superfluous labour or decoration, and offered at 11*l.* 10*s.* This cart is well adapted for all farm purposes, such as carting lime, sand, or stone, as well as manure from the farm-yard; at the same time it is light and handy, and capable of carrying sufficient to load a pair

of horses. It is yet a debatable question with farmers and manufacturers, whether the wheels of carriages should be strictly cylindrical or dished. There is also a difference in opinion as to whether the hoop should be slightly convexed or otherwise. A slightly convexed sole has without any doubt some advantages in the field, where young clover-seeds or grass-lands have to be carted over. Less mischief is done by the convexed sole than the flat; the latter by its sharp edges cuts the grasses, and leaves an indentation not noticeable in the other. In awarding the premium to Milford's cart, it is not intended to overlook the many carts placed in competition with it, which were in themselves creditable to the exhibitors. Perhaps some were too heavy, and consequently too dear; others might again be too high on the wheel, or too small in the body.

Steaming Apparatus.—In this department there was little competition, the contest being between W. P. Stanley, of Peterborough, and Richmond and Chandler, Manchester. The principle of these steamers is the same as those exhibited for several years; they are extremely useful on every farm, particularly in seasons like the present, when a considerable portion of the hay crop has been damaged by rains.

Churns.—In the churns there was some novelty. The Society's premium of 3*l.* was contested for by a practical trial in the show-yard, each churn having a quantity of cream measured out for the purpose of testing their relative merits. The following is a tabular statement of the time required for producing butter, and the quantity made from each churn:—

Name of Exhibitor.	No. of Stand.	No. of Article.	Quantity of Cream given to each.	Time in producing Butter.	Weight of Butter from each Churn.
			Quarts.	Minutes.	lbs. oz.
Dray and Co. (Willards)	33	29	4	18	3 14
Hancock	55	1	8	14	3 0
Burgess and Key . .	67	10	4	16	4 6
Dodds	103	1	4	17½	3 8

The butter was of excellent quality, and did not vary either in taste or appearance. In this trial, the American churn, exhibited by Burgess and Key, not only maintained its character in producing butter rapidly, but in producing a greater quantity from the like amount of cream. The plan of forcing continually atmospheric air into the cream by means of a cup-form given to the dasher seems to have a beneficial effect in separating and collecting the buttery particles. The old form of the piston-dasher does not at present possess this; and it may be owing to the want of this continued supply of atmospheric air, more than mechanical agitation, that the old dasher makes less butter, and

requires more time to make it in. The churn exhibited by Messrs. Burgess and Key was fairly entitled to the premium.

Draining-tools.—The premium of 3*l.* for the best draining-tools was awarded to Harry Winton and Sons. It is very difficult to decide on the relative merits of these tools and those exhibited by Mapplebeck and Lowe, of Birmingham, and made by Lyndon. Each are excellent in their way, and the digging-forks exhibited by each of these firms are superior in point of general usefulness and economy to any before offered to the public. Great improvements have taken place in the manufacture of common tools, such as forks, spades, draining-tools; their lightness, strength, and elasticity sufficiently recommend them to those engaged in every-day toil.

Medals.—In the distribution of medals, it will be proper first to notice those articles most important in an agricultural point of view, particularly where a new principle is introduced. Fowler's draining-plough, during the trial to which it was subjected, performed the work in an admirable manner and to the satisfaction of those called on to inspect and report upon it. The ground the plough was tried upon was an open friable loam, with a retentive clayey subsoil, having occasional stones, but of a general uniform character, and well adapted to give this novel implement a fair trial. The plough was first introduced to the Society at the Exeter Meeting; it has since undergone some improvements. At that time it was not supposed that ordinary drain-pipes would bear the pressure required, and wooden ones were provided at considerable cost. Subsequently it was discovered that the common drain-pipe, well made and well baked, would bear the pressure, and these are now successfully laid down at a reduced cost; but larger ones can be used, and it is a question with the Judges whether it would not be advantageous to use a larger mole and a larger tile. It is obvious that the smaller the tile the greater the risk in preserving a continuity of the aperture; for this reason the socket-pipe is recommended, but this adds to the cost, and the bell-mouthed pipe has been found on trial not to succeed. In working the plough it is very desirable to have the rope, to which the tiles are slung, exactly to fill the tile, so that there shall be no chance of displacement by stones or other obstructions. The machine is drawn with a windlass by 4 horses, and, at a depth of 3 feet 6 inches, moved at the rate of 10 feet a minute, taking the tiles slung on the rope with the mole, and leaving them with the greatest precision and regularity. The number of acres drained by this implement per day will depend on the distance of the drains apart. The cost per day in working it will be, *exclusive* of tiles,—

	£.	s.	d.
4 Horses at 4s. a-day . .	0	16	0
4 Men at 3s. do. . . .	0	12	0
2 Boys at 1s. do. . . .	0	2	0
Hire of machine, per day . .	0	10	0
Total . .	£2	0	0

If the Judges are permitted to throw out any hint or suggestion to the inventor, it would be to double or treble the length of the mole, to prevent, as far as practicable, the immediate reaction of the compressed clay upon the tile. A short mole will not accomplish this so fully as a longer mole: for it follows, the longer the mole is in going through the clay, or whatever strata it may be, the longer will it be before reaction takes place, and then in reduced force. For the successful working of this important implement, it is necessary there should be an uniformity of soil and surface. Trifling obstructions are of little importance, such as small loose stones and roots; these are readily removed by the mole, which pursues its straight and undeviating course; but where the subsoil rests on occasional rock the implement would not be available. It well deserves the medal it has obtained.*

Henry Brimsmead, of St. Giles, near Torrington, Devonshire, received the Society's silver medal, for an improved and simple method of shaking straw from a thrashing-machine. This implement will in all probability supersede the present shaker now in general use. It requires very little room, and can be so placed as to convey the straw to any required height or distance, while it will effectually shake the corn out of it.

Thompson's telescope drainage-level and staff is simple in contrivance, light and portable, and will answer all the purposes of the higher-priced articles in use, giving, without any calculation, the elevations and depressions. It requires the greatest care and exactness in the manufacture.

Gillam's seed-separator and seed-cleaning machine causes the seeds to pass over a large surface of wire screens, the openings of which increase in width as the seeds progress downwards. The machine is capable of some improvement in the mode of applying the power, and will be offered at considerably less money than the price named in the Catalogue.

The foregoing remarks affecting generally the Gloucester Meeting, as well as a Report of adjudications on "The Mis-

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* I understand that an important improvement has since been made in this implement by the adaptation to it of steam-power. —Ph. Pusey.

cellaneous," are respectfully placed in the hands of the Senior-Steward for examination and approval.

(Signed) JAMES HALL NALDER.
J. JEPHSON ROWLEY.

NOTE.—No award was made by the Judges on Prize No. 23 in the Gloucester Prize Sheet; no collection of Agricultural Tools for Hand-Labour appeared to have been made by any exhibitor. The description in the Prize Sheet was so vague and general that the decision was confined to the Prize No. 8 for the best Instruments for Hand-use in Drainage.

M. W. RIDLEY, Senior-Steward.

STEAM-ENGINES.

IN reporting to you on the steam-engines exhibited and tested at the meeting of the Society at Gloucester last month, we beg to state that, in consequence of the lowest consumption of fuel per horse-power having hitherto been taken as the measure of merit, we felt that, without the exhibitors having had previous intimation to the contrary, we should not be justified in deviating from this course on the present occasion, and have therefore made this the basis of our award, although, in other respects, several objections existed, to which we will hereafter advert.

The following tables contain the actual results of the several engines tested:—

PORTABLE STEAM-ENGINES—Tabular Statement of Results.

NAME.	Price.	Stand	Art.	Nominal Horse-power.	Time taken in getting up Steam to 45 lbs. Pressure.	Coals used in getting up Steam.	Wood used in getting up Steam.	While working up to their Nominal Powers.	
								Lbs. of Coal burnt per Hour.	Lbs. of Coal burnt per Horse-power per Hour.
	£.				Min.	Lbs.	Lbs.	Lbs.	Lbs.
Clayton, Shuttleworth, and Co.	175	72	2	4	47	17·75	20	17·26	4·32
Hornsby and Son . . .	215	40	1	6	42	29·46	20	28·93	4·82
Ransomes and Sims . .	245	20	19	6	229	28·54	20	33·00	5·5
Barrett and Co. . . .	200	69	2	6	41	20·00	20	36·58	6·09
Tuxford and Co. . . .	200	94	1	6	44	29·33	20	39·07	6·51
Garrett and Son . . .	190	22	26	5	33	31· 3	20	33·94	6·788
Bach and Co. . . .	155	37	1	4	40	17·52	20	38·91	9·73
Ransomes and Sims . .	215	20	20	6	65	30·35	20	54·4	9·068
Holmes and Son . . .	165	107	2	4	45	25·88	20	38·44	9·61
Burrell	205	24	1	6	40	29·35	20	62·59	10·43
Batley.	195	23	1	6	43	17·5	20	81·16	13·526
Burgess and Key . . .	150	67	2	4	51	35·47	20	76·29	19·07
Cambridge	175	50	1	5	Experiment not complete.				
Ferrabee, J., and Co. . .	200	78	1	6	Experiment imperfect.				
Carrett, Marshall, and Co. .	197	56	1	6	Unable to do work required.				

The first prize we awarded to Clayton, Shuttleworth, and Co.'s Engine, its consumption of fuel per horse-power being lowest. This engine was fitted with expansion valves, in addition to the usual slide valve, thereby increasing the number and complication of working parts. It was also very unsteady in its working, and required the greatest attention from both Mr. Clayton and an experienced mechanic to work it, the governor attached for this purpose not being used. The workmanship was in all respects very good, as well as the general arrangements.

The second prize we awarded to Hornsby and Son on the same grounds. This engine was fitted with a complicated expansion valve, and also with adjusting screws to several of the working parts, which, while in the hands of experienced mechanics, would be of service, yet in the hands of agricultural workmen would be most objectionable. The workmanship and arrangements of the several parts were very good. We think it right to observe, that this engine had been worked for several days by the Society for driving, thrashing, and other machines, which places it rather in an unfavourable position with others for trial.

We highly commended that by Ransomes and Sims. The consumption of fuel per horse-power was satisfactory, it was fitted with an expansion valve, and worked remarkably steady during the whole time of the trial with the assistance of its governors. The workmanship and arrangements were very good.

We commended that by Barrett, Exall, and Co. The consumption of fuel per horse-power was satisfactory; it was fitted with an expansion valve, but less complicated than those already mentioned. The workmanship and general arrangements were good.

We also commended those by Tuxford and Co., Garrett and Son, Bach and Co., Ransomes and Sims' Second Engine, as being plain, useful, and such as we could recommend for the purposes intended; they were not fitted with expansion valves. The workmanship and general arrangements very good.

That by Messrs. Garrett and Son was fitted with bearing springs, with a simple means of fixing the engine when required to work; we feel that the use of such springs is very advantageous when moving these engines over the rough roads which they are often required to pass; the whole of this engine, with the exception of the fly-wheel and cylinder, is of wrought iron, thereby reducing its weight considerably, without interfering with the required strength of the several parts.

With reference to the other engines tested, we have pleasure in referring more particularly to that by Holmes and Son as simple in its construction, well proportioned and easily repaired, and the workmanship good; that by Mr. Burrell was also simple and well proportioned, and a useful farmer's engine.

FIXED STEAM-ENGINES—Tabular Statement of Results.

NAME.	Price.	Stand	Art.	Nominal Horse-power.	Time taken in getting up Steam to 45 lbs. Pressure.	Coals used in getting up Steam.	Wood used in getting up Steam.	While working up to their Nominal Powers. Lbs. of Coal burnt per Hour.	Lbs. of Coal burnt per Horse-power per Hour.
	£.				Min.	Lbs.	Lbs.	Lbs.	Lbs.
Clayton, Shuttleworth, and Co.	165	72	3	6	..	..	..	38·78	6·46
Barrett and Co. . . .	175	69	5	8	..	..	..	52·9	6·61
Tuxford and Co. . . .	160	94	3	6	..	..	..	47·62	7·93
Dray, W., and Co. . .	150	33	2	6	..	..	..	48·86	8·14
Ransomes and Sims . .	210	20	22	8	..	..	..	65·82	8·22
Hornsby and Son . . .	200	40	4	8	..	..	..	69·6	8·7
Carrett, Marshall, and Co. .	175	22	27	5	Unable to do work.				
Turner and Co. . . .	156	93	1	6	Unable to do the work.				

To Clayton and Co. we awarded the first prize for the same reason as with the portable engines. This engine was fitted with expansion valves, all the parts well arranged, simple, and easy of access. The workmanship was very good.

To Barrett, Exall, and Co. we awarded the second prize. The workmanship of this engine was good, and generally the parts well arranged and simple.

That by Tuxford and Sons we highly commended: the consumption of fuel was satisfactory; workmanship very good; but the general arrangement gives more working parts than are desirable.

That by Dray and Co., Ransomes and Sims, and Hornsby and Son we commended, as being well arranged generally, simple and easy of access, and of good workmanship.

As we have before stated, in making the foregoing awards we felt that the objects of the Society were not secured, viz. to obtain engines composed of the least possible number of working parts sufficient to produce the best practical results as to power and economy, both in consumption of fuel and repairs. As such engines are intended to be placed in the hands of those who hitherto have had little or no experience, either in their management or repairs, it must be of the utmost importance that they should require as little attention as possible. We find that manufacturers have given their whole attention to one point only, viz. a low consumption of fuel, which has evidently been encouraged by the principle upon which the tests have been applied and the prizes awarded; this has introduced great complication of parts, and entirely set aside the main objects required, *i.e.* simplicity and utility. This is freely admitted by the manufacturers themselves, and, in some cases, two classes of engines were

exhibited, viz. the Racer to compete for the Society's prize, and the Working or Commercial Engine.

We therefore beg strongly to recommend, for the consideration of the Council, that in future exhibitions the superiority of one engine over another should be considered with regard to their simplicity of arrangement, each part being well proportioned and easy of access and repair, combined with steady and economical working and weight, and of course price.

Should this be carried out, we have no hesitation in believing that very great benefit will be secured to the agriculturist.

We are, Gentlemen, yours, most obediently,
WM. OWEN,
JOHN V. GOOCH,
Judges of Implements appointed by the Council.

NOTE.—I most cordially approve of the suggestions made for the future qualifications of competing Steam-Engines.

ANTHONY HAMOND.

Stratford, Essex, August 12th, 1853.

THRASHING AND CORN-DRESSING MACHINES.

TWO-HORSE POWER PORTABLE THRASHING-MACHINES, with Horse Works, for Small Occupations.

Perfect Work represented by						20	12	8	
Stand.	Art.	Name.	Number of Revolutions on Engine.	Time in Minutes to Thrash 75 Sheaves of Wheat.	Amount of Horse-power consumed for 1 Minute.	Clean Thrashed.	State of Corn.	State of Straw.	Price.
									£.
78	20	Ferrabee	1212	8·917	17·834	17	12	7	40
107	5	Holmes	627	4·61	9·22	19	12	7	30
22	15	Garrett and Son . .	844	6·205	12·41	19	11	6	36
20	25	Ransomes and Sims .	1052	7·735	15·47	20	12	7	38
58	5	Hensman and Son. .	583	4·286	8·572	17	11	7	36
69	10	Barrett and Co. . .	986	7·25	14·5	20	10	8	38

This prize was awarded to Ransomes and Sims. It will be seen, by referring to the table, that their machine performed its work well. The competition in this respect was very close between it and the one belonging to Barrett, Exall, and Andrewes, which, for its performances, the judges highly commend. The workmanship of the former was, however, superior to the latter, which they consider of great importance.

The great fault in the machines of this class is the very confined space under the thrashing part, and consequently the

difficulty there is in getting at the corn when thrashed. The two above mentioned were less objectionable in this respect than any of the others. It will be seen that some others did their work in much less time, but the judges thought it right to place the greatest stress upon good work and good workmanship. They commend the workmanship of those exhibited by Messrs. Garrett and Son, Ferrabee, and Hensman and Son.

PORTABLE THRASHING-MACHINES not exceeding Six-Horse Power, with Horse Works, for Large Occupations.

Stand.	Art.	Name.	Nominal Horse-power.	No. of Revolutions on Engine.	Time in Minutes to Thrash 75 Sheaves of Wheat.	Amount of Horse-power consumed for 1 Minute.	Clean Thrashed.	State of Corn.	State of Straw.	Price.
		Perfect Work represented by					20	12	8	
										£. s.
54	8	Hensman . . .	4	562	4·132	16·528	10	12	8	66 0
22	16	Garrett	4	695	5·11	20·44	17	10	7	56 0
40	6	Hornsby	4	597	4·38	17·556	12	12	7	75 0
20	24	Ransomes & Sims	4	912	6 705	26·820	20	10	7	57 0
69	8	Barrett and Co.	4	773	5·683	22·732	20	10	8	62 14
13	35	Crosskill	4	421	3·095	12·38	..	12	8	45 0
60	1	Maggs	4	734	5·397	21·588	15	11	7	52 10

This prize was also awarded to Ransomes and Sims. The work, however, done by the machine of Barrett, Exall, and Andrewes, in this class, was rather superior to that of the prize machine; it was also done in less time; but the workmanship of the latter was greatly superior to that of Barrett and Co's. This the judges consider a matter of great importance. It is quite certain a machine loosely put together will, when new, take less power to drive it than one that is tight in all its bearings, but the latter will undoubtedly be far more durable. The machine of Barrett and Co. had also a close drum, the casing of which is only one inch from the concave, which is considered unsuitable to mown corn in stony districts, as hard substances could not pass through the machine without injuring it, if more than one inch in diameter. With the exception of these two, the work done by the machines in this class was very indifferent; in one instance so bad that the straw was obliged to be thrashed over again. This, however, was less the fault of the machines than of the hurried manner in which they were fed. Time should undoubtedly be considered in these trials, but it should not be saved by wasting corn.

The judges commend the workmanship of the machines of Messrs. Hornsby, Hensman, and Garrett, particularly Hornsby's Horse-works and Garrett's Drum. The framing of Mr. Maggs' Horse-works is of wrought iron, but all this weight depends

upon a cross-bar of cast iron, which we think liable to break when travelling.

PORTABLE THRASHING-MACHINES not exceeding Six-Horse Power, with Shaker, Riddle, and Winnower, that will best prepare the Corn for the finishing Dressing-Machine to be driven by Steam.

Perfect Work represented by . . .							20	15	15	15	12	8	
Stand.	Art.	Name.	Nominal Horse-power.	No. of Revolutions on Engine.	Time in Minutes to Thrash 100 Sheaves of Wheat.	Amount of Horse-power consumed for 1 Minute.	Clean Thrashed.	Clean Shaken.	Clean Riddled.	Clean Chaffed.	State of Corn.	State of Straw.	Price.
													£.
95	5	Thompson . . .	6	The Screens blocked.									
69	7	Barrett and Co.	6	Screens blocked.									
22	19	Garrett	6	647	4·313	25·878	20	8	7	15	12	6	70
107	4	Holmes	6	Broke on trial, which caused blower not to work.									57
94	4	Tuxford	6	693	4·62	27·72	20	15	10	15	10	8	73
20	27	Ransome . . .	6	Hummeller choked.									85
72	4	Clayton and Co.	6	654	4·36	26·16	10	13	15	15	12	8	75
54	1	Hart	5½	888	5·92	32·56	20	15	15	15	8	8	80
6	3	Humphries . .	5	831	5·54	27·7	20	15	15	10	11	8	60
24	2	Burrell	6	619	4·126	24·75	20	14	10	8	10	6	70
23	2	Batley	6	919	6·126	36·75	18	13	..	..	12	8	76
40	5	Hornsby	6	869	5·793	34·758	18	15	14	15	12	8	80

The judges had some difficulty in making this award, but gave the award to Mr. Hart's machine. The dressing apparatus is very effective, and the great advantage of this machine over any other in this class is the very perfect separation and delivery in different directions of the straw, cavings, chaff, and corn, viz. the straw behind, the cavings before, the chaff by a cross blast on one side, and the corn by a short elevator into sacks on the other side of the machine. It has a close drum, but the beaters have a greater projection above the casing than most on this principle, being $1\frac{1}{16}$ inches. The judges commend Hornsby's machine for its general performances. There is, however, no separation of the chaff from the cavings, nor is the corn delivered into sacks, but falls from a spout at the side of the machine. They also commend Tuxford's, which, with the exception of defective riddling and slightly breaking the corn, did its work remarkably well. The fault in this machine, and it is common to several in this class, is the delivery of the corn, when dressed, into a very confined space under the machine, rendering constant attendance necessary to remove it. In the one exhibited by Mr. Batley the corn had to be got between the spokes of one of the wheels, but the arrangement, performances, and workmanship of this machine were most defective. With this exception, the workmanship of those above mentioned, and also of those of Messrs. Garrett, Ransome, and Clayton and Shuttleworth, is very excellent. The judges hope to see next year some machines in this class free from any of the objections enumerated.

Fixed Thrashing-Machine not exceeding Six-Horse Power, with Shaker, Riddle, and Winnower, that will best prepare the Corn for the finishing Dressing-Machine to be driven by Steam.

Perfect Work represented by . . .							20	15	15	15	12	8	
Stand.	Art.	Name.	Nominal Horse-power.	No. of Revolutions of Engine.	Time in Minutes to Thrash 100 Sheaves of Wheat.	Amount of Horse-power consumed in 1 Minute.	Clean Thrashed.	Clean Shaken.	Clean Riddled.	Clean Chaffed.	State of Corn.	State of Straw.	Price.
72	8	Clayton and Co.	6	1314	8·76	52·56	20	15	15	15	11	8	£. 70
22	20	Garrett	6	628	4·108	24·648	17	13	15	14	12	7	65

There were only two competitors. The best machine of the two was that by Clayton and Shuttleworth. It will be seen that the wheat was passed through Garrett's machine in less than half the time occupied by the other, but the work was not perfectly done. The workmanship of these machines was excellent. These exhibitors had each a fixed thrashing machine fitted up with complete dressing apparatus, by which the corn was finished for the market in a very perfect manner, and weighed into sacks.

There is one objection which we wish to notice that is common to both machines, viz., that the slow motions, such as the shogging-board, straw-shaker, riddles, and blower, are driven through the drum instead of having a separate belt from the driving shaft; it being mechanically wrong to get up a high velocity to drive slow ones.

The judges cannot help expressing their regret that a prize was not offered for a machine of this description, for, after the very decided proof given last year that all these operations could be perfectly performed by one machine, they cannot see why it should be limited to half its capabilities, and that too, at a time when the want of machinery that will supersede manual labour is more urgently felt. As there was no prize for these machines they were awarded a silver medal each. The Messrs. Ferrabee also exhibited a fixed thrashing machine, with complete barn-works, straw-cutter, and grinding-mill; but as it was not got into working order, the judges are not in a position to report upon it.

They again call the attention of the Council to the necessity of obtaining a supply of barley in the sheaf for these trials, for machines that will not thrash barley without injuring it for malting purposes ought no longer to be tolerated, much less rewarded and recommended by the Society's prizes.

CORN-DRESSING MACHINES for Large Occupations.

Stand.	Art.	Name.	Weight on Lever when at Work.	Tail Corn, 1st Dressing. Screenings.	Tail Corn, 1st Dressing. Spoutings.	Revolutions of Testing Machine during 2nd Dressing.	Best Corn.	Tail Corn, 2nd Dressing. Screenings.	Tail Corn, 2nd Dressing. Spoutings.	Price.
			lbs.	lbs.	lbs.		lbs.	lbs	lbs.	£. s.
9	1	Smith	$11\frac{1}{4}$	4	$3\frac{1}{2}$	30	$69\frac{3}{4}$	$\frac{1}{4}$	..	10 10
40	7	Hornsby	13	$7\frac{1}{4}$	..	45	327	$4\frac{1}{4}$	$1\frac{3}{4}$	13 10
91	8	Nicholson	15	$5\frac{1}{2}$	$7\frac{1}{4}$	67	242	$6\frac{3}{4}$	1	11 1

These machines were tried in the same way as last year, by each of them chaffing as much corn, rough from the thrashing machines, as they could during 62 turns of the testing machine, which is equal to two minutes of time. They then finished the quantity chaffed, and the results are given in the above table. This prize was again carried off by Hornsby, as also was the one for dressing-machines for small occupations: his competitors in this class failed to work.

OWEN WALLIS.
WILLIAM LISTER.

A. HAMOND, *Steward of Implements*.

GROUND IMPLEMENTS.

Ploughs for General Purposes.—The principle upon which to judge the merits of a plough was assumed to be this:—the display of a clean-cut, level-edged, unbroken, rectangular furrow, as exhibiting the work of a plough perfect in all its parts. Such a plough is supposed to possess a share and mouldboard that, in cutting and turning, will best preserve the furrow-slice in the natural bend and twist it takes in the action of turning over; and to attain this, not only a perfect shape, but very ample length of mouldboard, is found to be necessary. The coulter must perform its part so as to form on a level surface a true vertical cut, to match a perfectly horizontal sole. The next requisite is a well-formed skim coulter, which should so pare off the inequalities of the upper surface of the intended furrow that it should fit down evenly on the back of the one last turned, and form so close a seam that the growth of grass or weeds through any aperture be effectually stopped; while the parings of this skim coulter should, by a chain with a weight attached, be swept off the turning furrow, together with other loose matter, into the bottom of the furrow. For a furrow compactly turned, as above described, will be found to be equally

disintegrated throughout, while the furrow exhibiting various cracks and fissures will at the next operation be discovered to be comparatively a series of clods. The position at which the furrow should rest when turned over is supposed to be most correct when lying at an angle of 45° with the perpendicular cut of the land-side: at the same time it must be thrown aside sufficiently far to form a roomy horse-walk. And a plough performing these conditions most perfectly was found in the prize implement *to work at the lightest draught.*

The soil at the place of trial was in a very favourable state for ploughing, and for testing the merits of the selected ploughs. It was a clover-field from which a crop of hay had been lately removed; and a considerable quantity of the rakings was left behind, which exhibited the capacity of the ploughs for turning growing tufts out of sight. The appointed depth was first 5 inches, then 7. Among the number which had been sent out from the implement-yard, the superiority of that class, with which Mr. Howard's name has been so long connected, was soon evident, and an interesting struggle took place here, and afterwards in the heavy-land field, between four of these ploughs for general purposes, Mr. Ransome's, Mr. Howard's, Mr. Busby's, and Mr. Bell's, which resulted in favour of Mr. Busby's. The draught was recorded by Mr. Bentall's new dynamometer in a very satisfactory manner, in the heavy-land clover-field, with a furrow 6 inches by 9 inches wide, and the results as summed up by Mr. Amos were—

Busby	154
Howard	167·8
Ransome	168·6
Ball	195

The Heavy-land Ploughs.—These had an equally favourable field for their trial. Five of the before-mentioned class of ploughs alone competed, namely, Busby's, Ransome's, Howard's, Ball's, and Williams's. The contest was closely maintained by Ball and Busby, and was ultimately decided in favour of Mr. Ball.

The Turn-wrest Ploughs exhibited no great merit. Mr. Lowcock's performed the best work. Mr. Comins's was of a respectable kind, considering that the mould-board compressed formed the land-side. Mr. Howard's Kentish turn-wrest reversed the furrow perfectly flat. An American turn-wrest was also a competitor; and it was, in reversing the mould-board, simple and ready. But it proved itself out of place in land at all adhesive; its short, abrupt mould-board jerking the furrow over in a very amusing manner, leaving the work with a half ploughed and half scarified appearance.

Subsoil Pulverizers.—The soil was favourable for the working

of these implements, and the prize was awarded to Messrs. Howard.

Paring Ploughs.—The implements of Comins and Glover were the only two that started for this premium; of which Mr. Glover's was decidedly the best.

Heavy Harrows.—These harrows were tested on some remarkably hard set furrows; and Williams's by the side of Howard's and Coleman's stood to their work in a most steady and efficient manner, and obtained the prize.

Light Harrows.—In light-land work Mr. Howard's principle of joints adapted itself admirably to ridge or furrow, while they can be made fast for level ground, if requisite. Carson's and Seaman's were a series of half-harrows, each with an independent draught, and therefore not well calculated to perform the steady, straight, equidistant series of lines requisite for good harrowing. But Seaman's appeared to possess a valuable stiff-jointed coupling. The work after Coleman's harrows had a good finished appearance, but the expanding and contracting principle would bespeak an irregularity of stroke.

Cultivator, Grubber, or Scarifier.—The implement which is eligible for a premium under this head is one which is arranged for performing the two operations of grubbing and scarifying, that is, for grubbing, dragging, or by what other terms working a cross-ploughed ground with tines, or points, is called; and for paring, or scarifying, whole ground with shares fitted on in the place of points. A considerable number of this description were put on trial, and most of them were good and effective. Some few, as Hart's and Crosskill's "Uley," possessed a leverage which enabled them to be adapted to their work while in motion; and two, Coleman's and Ransome's "Biddle," had a leverage for raising or lowering either wheel in the vicinity of a ridge or furrow, Ransome's being much the most ready. Some, arranged with fore and hind wheels at a distance apart, were unable to reach their proper depth in the furrows of the high-ridged lands (or stretches); they had to work across, while they stuck fast at the ridge. The state of the soil from the falling rain was not favourable for trying the shares. Messrs. Ransomes and Sims' "Biddle" obtained the prize.

Pair-Horse Scarifiers.—Mr. Coleman's implement, upon the same principle as his four-horse cultivator, obtained the prize in this class, which is well adapted for stetch-work or uneven surfaces, the frame-work being short. Mr. Hart's pair-horse scarifier was commended for level lands, and well calculated to grub light soils, sands, &c.

Horse-Hoe on the Ridge.—Where a considerable depth or much cleaning is required, it is probable that a heavier imple-

ment than Messrs. Howard's, which received the prize, would be required.

Horse-Hoe on the Flat.—Mr. Garrett's kept the position it has so long maintained.* A patent universal horse-hoe, invented by Mr. Robert H. Nicholls, of Bedford, and shown by Mr. Williams, possesses a new steerage principle, by which the hoes can be readily directed along (to the extent of 1 yard) drills that may happen to diverge from the course in which the horse is walking. The advantage of this principle could not be well tested for want of corn-drills, either in a springing state or in stubble, in which the required defect in drilling existed.

Norwegian Harrows.—These tools had not the opportunity given of showing themselves to the best advantage—such as performing the double operation of harrowing and rolling in fresh ploughed ground, or in teazing grassy clods, &c.; but none that were tried appeared calculated to work more efficiently than Mr. Crosskill's.

Clod-Crushers.—A fair trial was given to these implements, and the contest lay between Crosskill's and Gibson's; and the former was found still to be the best crusher, for, though the work of Gibson's presented a finer surface, it was found on again

* Having last year recommended the cross-hoeing of turnips, five rows at a time, with Garrett's *horse-hoe* instead of singling them by hand, or leaving them, when labour is scarce, till the proper time is gone by, I beg strongly from further experience to renew that recommendation. A writer has said that this plan can be rarely adopted, because the plants seldom stand thick enough in the row; but, apart from cross-hoeing, seed enough should be used to *make* them stand thick enough in the row as a safeguard against the turnip-beetle. One of the largest and best English farmers, in his Report on Cambridgeshire, recommends the use of 3 or 4 lbs. of seed to the acre, which certainly will give more than enough plants for cross-hoeing. Another, Mr. Hudson of Castleacre, has this year bought two newly-invented horse-hoes, expressly made for singling out turnips grown *on the ridge*, which of course cannot be *cross*-hoed. But on the flat, as I have shown (Journal, vol. xiii. p. 202), no new or expensive implement need be bought. The same horse-hoe can be worked both ways, which surely is some advantage. This year a large piece of Swedes so cross-hoed at this place averaged 20 tons to the acre, and a large piece of turnips gave 30 tons. They were seen by good farmers at the trial of reaping-machines, and considered large crops. They certainly showed no blank spaces. Mr. Eggar informs me that on Lord Portman's farm he cross-hoed this year 200 acres of turnips in the same way.—Ph. Pusey.

applying the harrows that the whole mass was not so well broken as by Crosskill's. Gibson's is probably valuable as a wheat-presser, having proved itself a good self-cleaning implement. Crosskill brought out a new implement, which he called "a Self-Cleaning Clod-Crusher." It contains the new principle of alternately a large and a small disc, the centre bore of the smaller fitting the axle, and the centre bore of the larger being as much bigger as the difference in their whole diameter. They all touch the ground on the same level, and in revolving rub and clean one another; working loosely. It was reserved for another year's trial to consider its claim to a medal.

Digging Machine.—This machine is not, as was anticipated, a substitute for the plough, as the power required for that operation was considerable, but appeared well calculated to break up an old furrow-slice or raise up a depth of 3 or 4 inches, the surface of stubbles, &c.; the soil then seized by the teeth or prongs, being elevated to the height of 7 or 8 inches, was broken and left to fall therefrom; consequently, the specific gravity of the roots, weeds, &c., being less than that of the soil, the former were left on the surface. Two of these were tried. Bleasdale's, being more a cleaning than a digging machine, was considered inferior to Mr. B. Samuelson's, to whom a medal was awarded.

Water Drill.—Two of these competed for Mr. Pusey's special prize of 10*l.*, which was awarded to Mr. Chandler's drill, exhibited by Messrs. Reeves, of Bratton, Wiltshire.

Revolving Horse-Hoe.—Of these novel implements two were tried; the one invented by Mr. Martin, of Barmer, Norfolk, and exhibited by Garrett and Son, was very efficient in thinning young turnip-plants, leaving from 2 to 4 at regular intervals.

Dynamometer.—Mr. Bentall's, of Maldon, Essex, is an ingenious and clever instrument, and fully merited the prize offered.

A double-ridge plough, and an assortment of ploughshares, &c., belonging to Messrs. J. and J. Howard, were commended.

H. J. Hannam.
Thos. Scott.

Broom Close, Ripon, August 13*th*, 1853.

Report on Drills.

A proper comparison cannot be drawn on the different merits of drills exhibited this year with those of last, because the same Judges were not acting this year. So little novelty appeared that a lengthened report would seem only to be a repetition of former ones.

Prize 13.—For the best drill for general purposes there were four in competition. The prize was given to Messrs. Garrett, yet a strong adversary was found in Messrs. Hornsby.

Prize 14.—For the best steerage corn and turnip drill there were only two in the field, both of which performed well; but that of Messrs. Hornsby was best in point of construction, and more easily controlled when the ground was stony and rough.

Prize 15.—For the best drill for small occupations there were nine selected. Most of them performed well, but the preference was given to Messrs. Smith as the most desirable for small occupations.

Prize 16.—For the best and most economical small occupation seed and manure drill for flat or ridge work. Messrs. Garrett's figures here, in comparison with two others, as the best implement, and merits the prize.

Prize 17.—Messrs. Garrett carry the prize against three others for turnip-drill on flat.

Prize 18.—Messrs. Hornsby's figured with three others. The performance was good, and also the construction of the implement.

Prize 19.—Drop drill. Messrs. Garrett's was as successful as last year in performing its work best, and more perfectly than the other two that were in competition with it.

Prize 20.—Manure distributor. Prize, as last year, given to Messrs. Garrett, exhibited against four others.

It will be seen by the foregoing remarks, that the majority of prizes are, as usual, carried off by the makers that have been so successful hitherto. From the wet season and the nature of the ground, which was called "light soil" in the neighbourhood of Gloucester, it was a matter of surprise that the implements performed so well.

J. Druce.

Chaff Cutters, &c.

We have to report that the implements which came under our notice were rather numerous, and of that description which rendered it imperative that they should be tested with respect to the power they consumed to work them. This necessarily occupied a good deal of time, so much so, that we consider it desirable that the society should be provided with an extra "hand testing machine," and an extended platform or tramway to work it upon.

More time could thus be given to each experiment, and more correct results obtained; our time would not then be wasted by waiting during the fixing of the various implements to the testing machine.

Chaff Cutters, to be worked by Horse or Steam Power.—These machines, generally, did their work well: the principal difficulty in chaff machines is met with through their choking at the "mouth-piece;" although we had the straw with which they were

tried, (purposely) much broken and entangled, there was not much to complain of from the difficulty alluded to.

Stand.	Article.	Name.	Time of Working	Weight of Chaff-cutter.	Chaff Cut per Hour.	Horse-power used.	Chaff Cut per Horse-power per Hour	Price.
				lbs.	lbs.		lbs.	£. s. d.
22	28	Garrett and Son . .	3 Minutes.	49¼	995	2	492½	17 17 0
33	11	Dray and Co. . .		38¼	765	2	382½	14 14 0
36	6	Smith and Ashby .		59	1180	1½	786¾	12 0 0
77	1	Cornes		60½	1210	1	1210	14 0 0
69	23	Barrett, Exall, and Co.		35	700	1½	466⅔	11 18 0
97	15	Williams		49½	990	1	990	12 12 0
111	5	Richmond and Co. .		42¾	855	1	855	10 0 0
78	21	Ferrabee		66¼	1325	1½	883⅓	15 0 0
20	32	Ransomes and Sims		47½	950	1½	633⅓	11 0 0
64	3	Allcock		49	980	1½	653⅓	10 0 0

We awarded the prize to Mr. Cornes of Barbridge, near Nantwich, Cheshire; his machine doing its work in an excellent manner, both as to quantity and quality, the machine being also well made and simple in construction.

Chaff-cutters worked by Hand Power.—These machines were each worked four minutes, and the following table shows the amount of chaff cut, and the power required to work the machine.

Stand.	Art	Name.	Weight of Chaff Cut.	Weight on Lever.	Weight Cut per Hour.	Power required to Cut 1 lb.	Price.	Remarks.
							£. s. d.	
77	6	Cornes . .	10¾	10	161¼	·93	4 15 0	Excellent work both in long and short chaff. Machine well made and simple in construction, which, in opinion of the Judges, is of great importance.
22	29	Garrett . .	6½	9	97½	1·38	6 6 0	
20	33	Ransome .	17½	19	262½	1·08	8 0 0	Good work.
111	2	Richmond .	10¾	13	161¼	1·20	7 0 0	
36	18	Smith and Ashby .	10	14	150	1·4	6 15 0	Very good work.
33	14	Dray and Co.	8½	13	127½	1·52	6 10 0	
64	4	Alcock . .	9½	15	142½	1·57	7 0 0	
75	2	Fletcher .	..	..	..	..	5 5 0	Failed through choking.
96	3	Webb . .	4¾	10	71¼	2·1	4 4 0	
96	1	Ditto . .	7¾	14	116¼	1·8	8 0 0	
84	2	Harman .	..	..	..	..	3 10 0	Failed through choking.

Prize awarded to Mr. Cornes, Stand 77, Art. 6.

Grinding Mills.—Each mill was put to work, and ample time was given to each exhibitor to fairly adjust his mill, the produce was then taken, for five minutes working, with the power required for working the mill as follows :—

Stand.	Art.	Name.	Kind of Mill.	Horse-power required.	Meal ground in 5 Minutes.	Quantity ground per Hour.	Quantity ground per Horse-power.	Price.
								£. s. d.
19	1	Harwood	Metal . .	1⅛	11¾	141	125·3	22 16 0
16	1	Hays	Peak stone .	3	14½	171	58	12 10 0
17	10	Clayton, Shuttleworth, and Co.	Ditto . . .	4	29¾	347	89·25	45 0 0
106	2	J. Hart	French Burr	4	13¾	165	41·25	25 0 0

The judges awarded the prize to Messrs. Clayton and Shuttleworth, for producing the best "meal," which is the condition on which the prize is given by the Society.

The work done by Hurwood's steel mill was greater in quantity, but, as it did not give off its work in the softened state that stones leave theirs, we could not award it the prize. We, however, think it a very useful implement, and that it will do its work in a manner satisfactory to many farmers; hence, we think it would be well, were the Society to give an additional prize for steel mills.

LINSEED AND CORN CRUSHERS BY STEAM.

Stand.	Art.	Name.	Time of Crushing 14 lbs. of Linseed.	Horse-power.	Quantity of Linseed Crushed.	Linseed Crushed in 1 Hour.	Time of Crushing 8 lbs. of Oats.	Horse-power.	Quantity of Oats Crushed.	Oats Crushed in 1 Hour.	Price.
			m. s.			lbs.	m. s.				£. s.
4	1	Stanley .	3 54	1	14	215¼	1 55	1	8	248½	13 2
20	45	Ransome	2 45	1	14	304¼	1 0	1	8	480	12 0
93	2	Turner .	0 54	1	14	933¼	0 53	1	8	538	13 13

We awarded the prize to Messrs. Turner and Co. of Ipswich, for the superior manner in which it did its work.

Cake Crushers for every variety of Cake.—We were least satisfied with the trials of these implements, as the cake provided was too thin and soft; we regret that we were not furnished with some of the thick and hard foreign cake, which would have been much better adapted for showing the true merits of the implements.

Stand.	Article	Name.	Quantity Crushed in 2 Minutes.	Horse-power.	Quantity Crushed per Horse-power per Hour.	Price.
			lbs.		lbs.	£. s. d.
33	9	Dray and Co.	40	1	1200	10 0 0
22	30	Garrett and Son	99	0½	5940	10 10 0
40	17	Hornsby.	112	0½	6720	7 10 0

We awarded this prize to Messrs. Garrett and Son, for the superior manner in which it did its work.

Messrs. Hornsby's is a cheap machine, did rather more work than Garrett's, but did not do it so well.

OIL-CAKE CRUSHERS FOR THIN CAKE.

Stand.	Art.	Name.	Quantity Crushed.	93 Revolutions equal 3 Minutes.	Comparative Power.	Weight on Lever.	Price.
			lbs.			lbs.	£. s. d.
91	4	Nicholson	16	93	29·06	5	5 5 0
91	1	Ditto	21¾	93	29·93	7	3 0 0
40	18	Hornsby	49½	93	22·54	12	4 4 0
40	17	Ditto	27	93	37·88	11	7 10 6
22	31	Garrett	60½	93	19·98	13	6 16 6

We awarded the prize to Mr. Nicholson of Newark.

The reasonable price of his machine, places it within the reach of all, and it did its work well and easily by the power of one man.

TURNIP CUTTERS.

Stand.	Art.	Name.	Revolutions on Break.	Weight on Break.	Quantity of Roots Cut.	Comparative Power to do the Work.		Price.
								£. s. d.
68	2	Samuelson . . .	18 / 21	13	28	234 / 273	Bullock / Sheep	5 10 0
14	1	Kealey	24 / 21	16	28	384 / 336	Sheep / Bullock	5 10 0
51	9	Carson	22	13	28	286	Sheep or Bullock	4 4 0
109	8	Marychurch. . .	26 / 13	11	28	286 / 143	Sheep / Bullock	4 0 0
20	34	Ransome and Co. .	36 / 27	9	28	324 / 243	Sheep / Bullock	4 5 6
76	41	Fowler and Fry .	24 / 50	17 / 10	28	408 / 500	Fine / Coarse	7 10 0

The machine of Mr. Samuelson of Banbury, being both simple and efficient, we awarded it the prize.

We also highly commend the "Moody turnip cutter," exhibited by Mr. Carson of Warminster.

This machine not only cuts the turnips exceedingly well, but also cleans them during the operation; but whether the "gouge-shaped" knives, as placed, will stand the work when the turnips are frozen, requires time for proof.

DRAIN-TILE MACHINES.

Stand.	Art.	Name.	Length of each Pipe.	Total Length of Pipes in Inches.	Diameter of Pipes.	Number of Pipes made.	Time in Minutes.	Comparative Power for each Hundred Inches of Pipe.	Number of Revolutions of Testing Machine.	Weight of Lever.	Price.
										lbs.	£. s.
8*	1	Armitage	13	.	..	..	..	..	..	..	..
42†	1	Scragg .	13½	2133	2	158	5	129	122	25	16 0
15‡	1	Whitehead	13½	2262	2	175	5	116	125	21	21 0
97§	9	Williams	13½	1282	2	95	5	142	114	16	17 0

* Screened so badly, which caused broken pipes to such an extent that we do not record the experiment.

† The number of pipes produced, 158, including 29 bad ones. Box 18¼ wide, 8¼ deep.

‡ The quality of pipes very superior. The number produced was 175, including 5 only useless. Box 16⅜ × 9 in.

§ The number of pipes produced was 95, including 8 useless. Box 16¼ × 8⅓.

We awarded the prize to Mr. Whitehead, of Preston, for superior work, both as to number and quantity of pipes produced (when compared with the other machines); the excellent performance of this machine deserves especial notice.

William Shaw, *Cotton, Northampton*,
T. W. Granger, *Stretham Grange, Ely*.

General Report by Mr. Amos.

The city of Gloucester was well chosen for the place of meeting, and, had the weather been propitious, a much larger concourse of visitors would no doubt have attended, and embraced the opportunity of viewing the collection of implements, which were there produced for their inspection, and were certainly of a higher class, and of generally better workmanship, than have appeared at any former year.

For some years after the Society commenced its operations, it granted, at its shows, nearly unlimited space to exhibitors, which had the tendency of inducing them to bring too many articles of one description; thus, in fact, making it more a market for their ready-made articles, than an exposition of samples of their skill. Some salutary regulations have had the effect of checking the evil, and rendering the show more in character with the object of the Society; and any particular machine now exhibited is not brought so much with a view of selling it, but is intended to show the public a specimen of the skill of the exhibitor, and of what he is capable of producing. Hence, the statistics given in the following table will place prominently before the reader the increasing usefulness of the Society, for, notwithstanding the before-mentioned check, the articles exhibited have not decreased in number, and at the same time have increased in variety and value:—

A Table showing the Number of Exhibitors and the Value of the Articles Exhibited.

Date.	Place of Meeting.	Number of Exhibitors.	Number of Articles Exhibited.	Value. £ s. d.
1848	York	158	1640	16,215 16 1
1849	Norwich	145	1362	19,150 13 1
1850	Exeter	118	1197	12,182 10 7
1852	Lewes	103	1722	19,121 5 8
1853	Gloucester	121	1803	24,112 4 10

The judges of implements in the several departments have the facts before them, which enable them to report more fully

upon the particular implements which come before them, than the consulting engineer, who attends the meeting, and whose business is of a more general character, can be expected to do. I shall therefore confine myself to a few general remarks.

The portable steam-engines exhibited were numerous, and included many good ones in their number. Economy in the fuel required to work them was carried to a greater extent than is consistent with simplicity of arrangement; indeed the extra-expansion valves, double-action forcing-pumps, and a few other details of that character, which formed a part of the arrangements of some of the engines exhibited, are superfluous, and render the implement too complicated for the farmer's purpose. The following table, which marks the progressive improvement in the implement since 1849, will show that the prize implement at Lewes, which had in its construction none of the arrangements objected to, approached so near, in consumption of fuel, to the prize engine of this year, exhibited by Clayton, Shuttleworth, and Co., that the Society ought to discourage the adoption of such complications at any of its future meetings.

A Table showing the results of the Prize Engines at each Meeting since 1849; and at the Trials in Hyde Park.

Date.	Place of Meeting.	Lbs. of Coal per Horse per Hour.	Name of Exhibitor.
1849	Norwich	11·50	Garrett and Son.
1850	Exeter	7·56	Hornsby and Son.
1851	London	6·79	Ditto.
1852	Lewes	4·66	Ditto.
1853	Gloucester	4·32	Clayton, Shuttleworth, and Co.

A Table showing the Engines requiring the greatest amount of Fuel in each year, since 1849.

Date.	Place of Meeting.	Lbs. of Coal per Horse per Hour.	Name of Exhibitor.
1849	Norwich	25·5	Burrell.
1850	Exeter	28·0	Wm. Cambridge.
1851	London	25·8	Freeman Roe.
1852	Lewes	93·9	Ditto.
1853	Gloucester	19·0	Burgess and Key.

The fixed engines have not attained that degree of excellence which, it is to be hoped, will be developed; and, when durability is taken into consideration, the vertical cylinder will be found preferable to the horizontal one.

In both classes of engines for the farmer's use, no other expansion is admissible than that which may be obtained by a lap on the common slide.

The department of thrashing machines included many good implements, and several might have received higher marks for their performance, had the exhibitors been more intent upon doing their work well, than upon finishing it in the shortest possible time.

It will be to the interest of exhibitors to perceive, that as steam-thrashing machines will be most generally used, the power required to work them being so cheaply obtained is not of the same importance as when the machine had to be worked by horses; they may therefore calculate upon the judges paying more attention in future to the *manner* in which the work is done, than to the *power* required to do it: of course when two machines are equal in performance in every other respect, the lightest working machine should take the pre-eminence.

In grinding-mills there was not much competition. Clayton and Co.'s did its work the best; and when they carry out the plan suggested, for raising and falling the stones, the implement will be more useful, as with the present arrangement it is too limited in its range for all kinds of grain: this must have been an oversight, and no doubt will be attended to in future.

The metal mill exhibited by Thurwood is capable of doing a great deal of work in a short time, and with little power to work it. This mill does not grind the produce so fine as stones do, but many farmers do not object to this. It appears not very likely to get out of order, and a miller's services are not required. Probably it would be well to give a second prize expressly for mills of this class.

The new implement invented by Biddle, and exhibited by Ransome and Co., for splitting beans, &c., is a very ingenious contrivance, and will be found useful for many other than agricultural purposes.

The reaping-machines had this year a thorough trial of their capabilities, and every means was taken to ascertain their respective merits: the decision of the judges is fully in accordance with my opinion.

The machine invented by Bell, and exhibited by Crosskill, is an effective implement. It possesses great facility for cutting crops in the most tangled state, lays the cut corn well, and, in commencing its operations, requires no scythe-man to pioneer its way. The objections to this machine appear in its great weight, the heavy draught to the horses, and its cumbrous character, rendering it difficult for a common labourer to steer and manage. The great weight, and consequent heavy draught on the horses,

is required principally to overcome the friction of the knives. This friction is unnecessary, and a more simple knife may be introduced, which will render the machine exceedingly effective.

The machine invented by Mac Cormick, and exhibited by Burgess and Key, cuts crops that are not much laid very well; the draught to the horses is lighter than in any other machine capable of doing an equal quantity of work, and the knife is very cheap, simple, durable, and free from choking.

The machine was not well made, could not cut laid corn well, required the work to be begun by the scythe, and the mode of attaching the horses to the side of the machine is very objectionable, causing them much more strain and fatigue than would otherwise be experienced.

The machine invented by Hussey, and exhibited by Dray and Co., was well made, cut standing corn well, and the mode of assisting the delivery of the sheaf was good, but many may object to the cut corn being left on the back of the machine. The draught to the horses was rather severe, occasioned principally by their being attached to one side of the machine, and out of the direct line of draught. The machine would not cut laid corn, and the knives choked on several occasions.

From a careful inquiry into the construction of each machine, I was led to believe that a judicious combination of some of the parts of two or more of them would produce a truly useful implement.

Bell's mode of attaching the horses to the machine, and delivering the cut corn, appeared to be the best, but the friction of the knives was its drawback, and the expense of them (11*l.*) was also objectionable.

Mac Cormick's knife was simple, cut all that came before it, did not choke, and its first cost (13*s.*) is surely not its least recommendation.

Hence it appeared to me, that to take Mac Cormick's knife, and apply it to Bell's machine, instead of the shear-like knives he used, would be an important step gained, and the machine would be cheaper, lighter, and more effective.

Possessing these ideas, I spoke to Crosskill and to Burgess on the matter, and entreated them to make their interests mutual, and to manufacture such a machine as I had described. They appeared to fall in with the idea, and promised to take the matter into consideration. I have therefore great hopes that a useful implement will arise from the experiments at Pusey.

And, in this place, I cannot but remark how deeply the Royal Agricultural Society, and the agriculturists in general, are indebted to Mr. Pusey for the great facility he afforded the judges for practically testing the merits of this important implement.

All who were engaged in the experiments will ever remember his kindness and consideration on that occasion.*

C. E. Amos.

Grove, Southwark, 28th Sept. 1853.

The Judges' Report on Reaping Machines.

The Gloucester Trial.—For the trial of Reapers at Gloucester, circumstances were upon the whole propitious. The day was fine. The field laid up in narrow high-backed lands or stetches proved a good test of their working powers, and a rather straggling crop of rye within about ten days of being ripe presented in itself no particular difficulties to overcome. The work allotted to each machine was laid out across ridge and furrow. Twelve competitors started, who fulfilled their tasks with various success; and ultimately left five in possession of the field, namely, Hussey's own Improved, Dray and Co.'s Hussey, Samuelson's original M'Cormick, Burgess and Key's improved M'Cormick, and Crosskill's Bell. The work of these only was found sufficiently satisfactory to be reserved for a further trial at Mr. Pusey's farm, at Pusey, in Berkshire. To these was added Garrett's Hussey, on the credit of its well-earned character, though it failed in the present instance, from its being constructed only to cut on a level surface. The above five cut their stubbles, over high ridge or deep furrow, with equal evenness, their knives following the inequalities simultaneously with the wheels—Bell's, however, the least so, from being dependent on the management of the steerer; —and these generally performed their characteristic deliveries in a satisfactory manner:—Mr. O. Hussey's, which, together with Dray and Co.'s, gathers, by the rake of a man sitting on the machine, a sufficient quantity on the platform for a sheaf, and lets it off behind; M'Cormick's, which also by a man and rake pulls off the same quantity to the right side, out of the way of the return of the horses; and Bell's, which, by the action of an endless web, forming a revolving apron to receive the corn from the knives, turns out a continuous swathe. The self-delivery of this last, with the facility of turning the corn off on either side, was the most satisfactory and workmanlike of the whole. Dray and Co. assisted their delivery by a platform on a pivot, but which did not appear to possess a marked advantage over Hussey's own. They employed moreover three men, stationed at intervals, with light gathering forks, to lift and place the deposit on bands previously laid down; and this was devised to obviate the necessity of binding immediately after the machine. M'Cormick's deposits varied in degrees of evenness for binding, according as the corn leaned favourably or otherwise. Bell's, propelled by two horses yoked to a pole, manifested its independence by striking into the standing crop, and opening a passage for the horses 6 feet wide, and by cutting it in any direction. While Hussey's, managed by the veteran inventor himself, commanded general attention, by the style in which he surmounted the ridges and dipped into the furrows, while in a deliberate and workmanlike manner he collected and deposited each gathering in its proper quantity. But the complete trial was reserved for the Pusey meeting.

The Automatons exhibited by Messrs. Ransome and Messrs. Garrett excited at the same time a vast deal of interest. These, from some cause, failed to perform the reaping action with success. And the straggling nature

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* Since writing the above I have learnt that Crosskill and Co., with their usual promptitude, have constructed a machine on the principle recommended, to which they are about to give a public trial.—C. E. Amos.

of the rye crop prevented the action of the Automaton Gatherer being exhibited with advantage. The object of these is to effect a self-delivery, which is done by imitating the closing of a pair of hands collecting the corn together on the platform. The action is this: while the corn is falling before the knives, a long steel arm raises itself from the right side of the platform, swings to the opposite side, and with a capacious palm sweeps off the contents of the platform into the grasp of an equally expansive short-armed hand at the point from which it started; the bundle thus held fast, is swung round on to the stubble, out of the way of the returning horses, and dropped out, ready to be bound into a sheaf. And the long arm again stretches itself forth for another sweep. To obtain in any degree a neatly formed sheaf, it appears necessary that the crop should stand erect and fall directly at right angles with the stroke of the arm, otherwise a tumbled gathering is the result.

The Trial at Pusey.—The reserved machines, with the exception of Mr. Garrett's, met for further trial at Mr. Pusey's farm on the 16th and 17th of August. The weather proved singularly unfortunate; the rain fell nearly the whole of the time the machines were at work. Though this was disappointing as far as a display of the full effect of the inventions was concerned, and as to the gratification derived from arrangements made on the farm for the trials, and from the abundant hospitality provided at the mansion, yet enough was gone through to satisfy not only the judges, but apparently every attentive looker-on, on the question of the merits of the respective implements. They were tested in wheat, both upright and moderately laid; in barley much laid, and in erect barley full of young clover; in a stout leaning crop of oats; and in a thin crop of ripe winter beans. In cutting the standing wheat all the machines performed their work well, leaving an even stubble 4 inches to 6 inches high, and their delivery was generally such as would second the operations of the binder —fairly so in the case of the hind-delivery; less so in that pulled off sideways; more complete in the swathe-formed self-delivery. Bell's *fronting* principle had a manifest superiority over all the rest, which are formed for cutting the crop only on the near side of the implement. In a crop that can only be cut on one side, Bell's can reap both backwards and forwards, while the others are obliged to return *empty*. In the case also of a lodged patch lying to be cut on the off-side, a near-side machine must miss this patch, and continue passing *empty* by it, till the opposite side is exposed by the cutting of all the intervening piece: while Bell's machine can at once strike into it at the suitable point.

The laid crop of barley was a severe trial, being made doubly flat by the weight of the rain. All the exhibitors seemed to feel that few *laurels* were to be reaped with a crop in this state. The M'Cormicks showed little anxiety to undergo the trouble of putting their knives low enough. The Husseys choked, and the old American whom nothing daunted alone stuck to it; and Bell's could only meet it one way—directly against the lean—returning empty. However, those knives that were put well down, and when they did not choke or foul, cut it better than could have been expected, making fair work, except where the crop was in the extreme of flatness. When the upright barley was cut the rain had ceased, but its thick growth of young clover was equally wet. Bell's machine cut this crop well, both with a high and low stubble, but the swathe was a little irregular. Burgess's M'Cormick was set low, and performed its cutting extremely well, and showed its power of cutting grass. The original M'Cormick for want of speed in the knives cut very indifferently. This was not a state of crop in which the Hussey knives would appear to advantage, but their performance, with some stoppages, was respectable.

In the crop of oats, which was thick and leaning, all the machines performed their work efficiently where they set upon it on the side suited to them. In the ripe thin beans they exhibited the power of cutting such a crop when set tolerably low, with the exception of Dray and Co's. The wheels of both the

Husseys clogged from the soil being made sticky from the rain. Most of the machines showed an inability to make good work by the side of a deep furrow.

Each machine was subjected to a scrutiny by the judges, under the guidance of the consulting engineer. The original Hussey was much improved in its mode of adapting the forewheels, and attaching the horses, and the tendency of the corn and soil to foul the cog-work was corrected. The knives also by a simple contrivance were made much less liable to become jammed up in a grassy undergrowth.

Dray and Co's. is an exceedingly well-executed machine. Its mode of altering the height of cutting is very readily effected. It has a well-contrived method of carriage (at the extra cost of an axletree and pair of wheels) for travelling and getting through gateways. They also have an improvement in the knives for obviating choking. These are well made, forming a cutting edge at an acute angle. They are easily shifted; and the price of a spare set, which it is always desirable to have in readiness in the field, is 32*s*.

The M'Cormick Reaper exhibited by Mr. Samuelson presented the implement according to its original make, with its knives worked at a speed sufficient for the comparatively thin crops of America: and that by Messrs. Burgess and Key, as improved by M'Cormick for British husbandry, and with the speed of the knives much increased for cutting heavy crops. Though needing further improvement, this implement is undoubtedly a desirable addition to a farmer's stock. Its draught is easy, and its mechanism is simple, and its knives the most inexpensive and efficient of any exhibited. They are sickle-edged, each an obtuse angle of about 4½ inches long, riveted on a slight bar, and experience has proved that they are free from the least tendency to choke. They have shown themselves also respectable grasscutters, and their obtuse form renders them little liable to accident. The price of a spare set is only 16*s*., and that of a spare knife 1*s*. It is, however, a slightly built machine, and one wonders why the cost should reach 25*l*. Its extreme width is 9 feet. The workman seated upon it, aided by the weight of its reel, no doubt gives it sufficient steadiness to meet the resistance presented. This workman is also so placed as to poise the weight of the pole off the backs of the horses.

Mr. Crosskill's Bell was pronounced on examination to be good in its mechanical details. And an additional implement was also brought forward containing essential improvements, made since the trial at Gloucester; for instance, some gearing for continuing the action of cutting while turning, and in substituting wood for iron in the leverage of the reel, together with greater facility for altering its elevation. This implement exhibits an apparent unnecessary solidity of parts, and its weight is not less than 16 cwt. But Mr. Bell explained that such a weight is proved to be a necessary medium between the resistance and the propelling power. And such resistance, shown by the great exertion required of the horses, is much greater than that of its competitors—greater than appears called for in the additional power absorbed by the revolving apron, together with the good 6 feet width of cutting that is taken. The necessary bite of the wheels on the ground appears to be generally attained in the other machines by the weight of the raker seated upon them, but not entirely; for they have found it necessary to have raised strips across the surface of their wheels to prevent slipping. Bell's shears are a very expensive item; there are ten pairs, the price of each blade of which is 10*s*. 6*d*., making the total amount 10*l*. 10*s*. They are nevertheless very strong, and not very liable to suffer damage from the obstacles they may meet with. The lower range is fixed, while the upper row receives a movement from the cam-wheel, and accomplishes its very effective cutting.

In regard to the advantages and disadvantages of the different modes of delivery, that which drops off the corn behind, and which requires the binders to make a clearance before the machine returns, appears on most first trials to entail a very undue amount of hands, who, on the stoppages which

then more frequently occur, are thrown into a state of inactivity. Again, some who have persevered, and have mastered the difficulties of the machine, and have found out the right number of hands, have asserted that they do not object to this method, because it keeps their people on the alert.

A side-delivery is, generally speaking, more convenient, and meets occasions in which immediate binding is not proper; but this method often delivers the corn in a tumbled state for the binder. It appears, therefore, desirable, that where a manual delivery is employed, a choice of these two kinds should exist in the same implement. Now a question is, whether Dray and Co. have attained this combination? They deposit behind, and with gathering-forks they lift and place each parcel out of the way of the horses returning, on a band previously laid down by boys. This, however, seems wholly or in part an extra expense. It effects the same process that the side-delivery does, with the advantage of a band got in readiness under the gathering, but which advantage is attained at the expense of three men and two boys. Bell's reaper performs all that can be expected of a machine in regard to delivery; it perfectly imitates the best workmanship of the scythe. It produces a swathe spread for drying if the state of the crop requires it, or to be gathered and bound immediately.

Revolving Reel.—The *reel*, or collector, as Mr. Bell called it, performs important functions in M'Cormick's and Bell's reapers. It is necessary, because the form of their knives possesses no power of grasping the corn. This bite is in a measure given by the acute angle of Hussey's knives, while at the same time the position of the man on the machine enables him to bend the corn towards the knives, as well as gather it on the platform. The *reel* answers two purposes—one chiefly, by revolving inwards, to bend the standing corn towards the knives, and momentarily to retain it while the bottom thrust is taking place; the other, the sweeps being set with proportionate lowness, by revolving outwards, to lift a laid crop before the knives. At first sight the reel appears to be damaging the corn; but as it is made to revolve only at a small degree of speed greater than that at which the machine is travelling, only a slight pressure is effected.

In regard to the *economy* of these reaping machines, the comparison must be made with the *scythe*, and not with the *sickle;* for while the cutting portion of the latter is something like two-thirds, and the binding, &c., the other third, that of the former is not quite half, though in value equal to half; therefore must it be said, that by their operation of cutting the machines execute about one half of the work; the gathering, binding, and shocking forming the other half. It has been found by experiment that gathering, bondmaking, and binding take up about equal time, that is, each about one-eighth of the whole work. Thus a machine that gathers as well as cuts performs five-eighths of the work. In this respect Hussey and M'Cormick have an advantage over Bell. And it is a consideration for the proprietors of the latter machine, whether a little simple mechanism might effect this operation, to be put in action only when immediate gathering was required. A farmer has, therefore, in the first place, machines presented to him that will *cut* corn, whether inferior or not to manual work. In the next, they are brought before him in a sufficient state of advancement to cut the *majority* of his corn crops. He may thus depend upon them to supply a deficiency of labour; he may use them to save labour; or he may employ them as a help to expedite his harvest: this last proposition has hitherto, we know, not always been found to be a correct one. But both farmers and implement-makers are yet groping their way. One great point for the interest of both parties is, that the makers should send out the machines as perfect and as trustworthy as possible, and after having thoroughly tested them; for nothing will more effectually deter farmers from purchasing than the fear of being brought to a stand at so important a crisis as their wheat

reaping. The question of price is also another serious matter between the parties. Farmers are alarmed at the expensiveness of an implement that can only be used during two or three weeks in the year. Makers probably are not yet sufficiently at home in the manufacture to do it economically.

The following are the prices of the machines before us:

Samuelson's	£25
Burgess and Key's	25
Crosskill's Bell	42
Dray and Co.'s	18
Hussey's	25

It was calculated, in conjunction with Mr. Amos, that in the interest, &c., of the purchase, and in the wear and tear of Crosskill's Bell's Reaper, averaging about 12 acres of work a-day, the cost would be, on an arable farm of 400 acres, about 6*d*. an acre. It is probable that a farm of this size is the extent that one implement could manage. If the grass crops could be cut by the same implement, of course the expense would be reduced. If 12 acres is the average of Bell's implement per day, a proportionably less amount must be taken for the others, which cut from 6 in. to 12 in. less in width, and are more frequently obliged to go one way *empty*. The manual labour for each machine appears to be about equal. One man accustomed to the work will manage Bell's as well as one man can drive and guide a plough. If the other machines have two men, one for the horses and another seated upon it with a rake, the latter should not be put to the account of the machine, because he is gathering for the binder—he is performing a division of the harvest labour. Horse labour is the most serious item against Bell, in comparison with the others: judging by the way in which the horses were obliged to put out their strength, it is very doubtful whether four strong horses, in two relays, would be sufficient for the daily cutting of 12 acres of heavy crops.

The economy and efficiency of the mower's scythe is the point these machines have to reach and surpass. The process of gathering they have already entered into; and how soon they will be able to accomplish that of binding remains to be seen.

There were seen in the implements under review individual properties in each of a valuable kind, and also peculiar deficiencies which in a degree neutralized the good; again was seen amongst the whole most of the qualities requisite for a good implement; therefore, were the Judges, associated with other officers of the Society present, led, although they felt they were throwing a temporary impediment in the way of those who were anxious to procure a Reaper, to recommend in one or other of the machines, or in a new one, a combination of the properties which the present state of agriculture requires, and to embody such an opinion in the following award, which they drew up before they separated at the termination of the trial:—

"*Pusey, Berks, August* 17*th*, 1853.

"In making their award, the judges regret that, after having tested the reaping machines at Gloucester upon rye unripe, and consequently unfit for harvesting, they have now again been compelled (at this adjourned trial), from two days' extremely wet weather, to test the machines selected upon corn in such a state as, under ordinary circumstances, would not have been cut; they, however, have given the different reapers as full a trial as possible upon wheat, barley, oats, and beans; and, after carefully testing their merits, have unanimously awarded the Society's prize of 20*l*. to Messrs. Crosskill's 'Bell's Reaper.'

"They also 'highly commend' Messrs. Burgess and Key's reaper, upon M'Cormick's principle; and they 'commend' Messrs. Dray and Co.'s reaper, upon Hussey's principle.

"The judges have the satisfaction of reporting that a decided improvement has taken place in the working of the reaping machines brought under their notice; they are, nevertheless, of opinion that, by a combination of certain elements which exist in the various machines exhibited, there might be produced one surpassing anything hitherto brought before the public. Such an implement might be made to unite the advantages of simplicity in construction, greater durability, lightness of draught, and reduction in price, with the thorough capability of being more easily managed by the agricultural labourer.

"Wm. Fisher Hobbs, Steward of Field Implements.
"C. E. Amos, Consulting Engineer.

"Henry J. Hannam,
"Wm. Woodward,
"Joseph Druce, } Judges."

In the award that has been given, and in the above opinion that has been expressed, it is hoped that fresh stimulus will be given to perfect this class of implements.

Henry J. Hannam.
Wm. Woodward.
J. Druce.

APPENDIX.

Burcote, Abingdon, October 12, 1853.

Dear Sir,—Having been requested by Mr. Crosskill to come and witness a trial of his improvements in Bell's reaping machine, I went to Beverley for that purpose on Wednesday last, Oct. 5th. I met three gentlemen who had been judges at different trials of reapers this year in the North, and we came to a decision that considerable improvement had, in certain points, been effected.

The alteration consists principally in substituting a set of knives rivetted, on the Hussey and M'Cormick principle, on a straight thin bar, which is set in motion by a crank, instead of the former shearing apparatus worked by a cam-movement. These fixed knives are 24 in number, 3 inches long, shaped to an angle of 90 degrees, and with serrated edges. The trial took place on a piece of late wheat. It was immediately perceptible that the draught was lessened, and that the man who drove was placed more at ease, though he both held the reins and guided the machine. For at Gloucester and Pusey any irregularity of draught appeared to call forth a good deal of effort from the man at the end of the pole. On this point Mr. Crosskill observed, that when the horses are a little accustomed to the machine, and the driver is acquainted with the horses and the work, there never had been occasion for more than one person to drive and to steer. The set of knives, like M'Cormick's and Hussey's, is easily removed, and the price of a spare set, I understood, was 35*s*. I observed no tendency to choke. There was no under-growth, however, of consequence in the wheat to occasion it. But there were parties present on the ground, including one of the judges, who assured me they had cut the greater part of their crops this season with this set of knives applied to Crosskill's Hussey of 1852 without experiencing choking. The draught on the whole appeared as much under as it before appeared beyond the power of a good pair of horses. As the draught is lessened, so it is considered that the weight and stoutness of the implement may be reduced, which is being carried out in those that are in progress in the workshop. I learnt that Mr. Bell has seen and is quite satisfied with the alterations.

In regard to advantage gained in the simplicity of the cutting apparatus there appears now no art needed in fixing and removing it, while the shears, it is said,

require a good deal of practice to learn to adjust the proper bite; they will double the straw if too slack, and increase the draught when too tight. As to decrease of price I have not so favourable a report to give as one would expect: the reduction is only 4*l.*—namely, to 38*l.* Mr. Crosskill's plea is, that he was making the original implement almost at a loss.

On the whole, however, I hope enough of successful progress has been made to enable Mr. Crosskill to go on with confidence, and to satisfy the agricultural community that a step has been made in following out the recommendation of the Pusey judges without waiting a whole year.

I should have liked to have seen the adoption of M'Cormick's knives, if practicable, but as a medium between these and Hussey's I have hopes that the present attachment to Bell's reaper will be found equally valuable with the former.

I remain, dear Sir, very faithfully yours,

To the President. HENRY J. HANNAM.

XXIV.—*On the Natural Law by which Nitrate of Soda, or Cubic Saltpetre, acts as a Manure, and on its Substitution for Guano.* By the PRESIDENT.

THOUGH the plain path of practice is in agriculture generally the safest, it will not be useless for that very practice sometimes to deviate into theoretical considerations, the result of which may render the steps of experience more sure; just as the sailor, while buffeting with a stormy sea, ascertains his course by the abstruse calculations of the astronomer. Such a field of inquiry is, I believe, presented to us in the use of saltpetre as a manure.

This substance, or rather these substances—as there are two, the ordinary and the cubic saltpetre—consist of an acid, the nitric acid, and an alkali, either potash or soda; nor could any one, viewing the effect of these individual salts, decide whether the acid or the alkalies were the source of their manuring action. Looking, however, to the nature of other fertilizing matters, I ventured, so long ago as the year 1841,* to express the belief that their power would be found to reside, not in their alkalies, but their acid. Still the arguments then adduced were not thought conclusive, and in books subsequently published † it was yet said that the potash and the soda very probably were the manures, for the mineral theory was still in vogue.

Last year again, having some fresh facts to bring forward on nitrate of soda, I endeavoured to support the same view by showing further that other nitrates also, such as the nitrate of lime found in old walls, have likewise a manuring effect.

* Journal of Royal Agricultural Society, vol. ii. p. 123.

† "Both Nitre and Nitrate of Soda are used as manures, and it is still uncertain whether the acid of these salts contributes to the good effect, or whether they act by their bases alone."—*Outlines of Chemistry,* by O. Gregory, M.D.

Still the question has remained open, and the highest chemical authority in Edinburgh has recently questioned the manuring power of nitric acid; nor can any one blame that distinguished philosopher, Dr. Gregory, for exercising caution in admitting such an hypothesis. For if it be true that all substances containing nitrogen, in whatever form, are thereby constituted manures, this will not be a mere rule of farming, but an important law of Vegetable Physiology; the more important, perhaps, because we hardly know any other law under which vegetables acquire their substance, excepting that by which they absorb carbonic acid in daylight. Indeed, his opponent, Dr. Wilson, in an able paper* read before the Royal Society of Edinburgh last spring, advocated the efficiency of nitric acid with some hesitancy, admitting that "soda might be the more important constituent of nitrate of soda considered as a fertilizer." So long, then, as the productive power of nitric acid rested upon abstract reasoning, however cogent, the general law could not be regarded as finally valid. It appeared, therefore, desirable to bring the matter to a decisive experiment, and by employing the two elements of Nitrate of Soda, the acid and the alkali, separately, to ascertain in which of the two the manuring virtue is seated. It would be scarcely possible, of course, to use nitric acid upon acres of land, nor did it seem necessary, for we know the vivid green and the rapid growth induced upon grass by nitrate of soda. Whichever, therefore, of its two elements used side by side with itself, the alkali or the acid, produced the same vivid green and the same rapid growth, must clearly be the active principle of the combined salt.

In applying nitric acid for the first time as a manure, whatever confidence one might entertain in a scientific induction, one could not see the most powerful of acids eating away the very spoon which held it, or feel its acrid fumes in the lungs, without some misgiving as to its action upon the tender spongioles of the grass's roots. Considerable dilution was of course necessary, and the first point to be ascertained was the amount of water required to be mixed with the acid for the safety of the living fibres. Six stripes, then, each five feet long and one broad, having been marked out by pegs upon a grass-plot, these received severally from a watering-pot a pint and a half of water containing nitric acid, the proportion of which was successively decreased. Two other stripes also received nitrate of soda in different quantities. The three strongest doses of nitric acid had burnt up the growing grass by the following morning, but, to my great satisfaction, in about a week the next stripe showed unequivocal marks of benefit from the nitric acid.

* Transactions of the Royal Society of Edinburgh, xx. 41, read April 18th.

Soon after, one weaker solution had begun to act. It was only the weakest dose of all which produced no effect. The three strongest too had killed the blades alone of the grass, not the roots, which in about a fortnight sent up a new crop of deeply discoloured herbage, resembling that produced on their side by the nitrate of soda. The quantities of acid applied are given in the following table:—

September 22.

Manure employed on Area of 5 square feet.	Quantity in Drachms.*	Water in Pints.	Effect on Grass, perfection being taken at 10.
Nitrate of soda . . .	6	1½	10
Ditto	3	..	9
Nitric acid of commerce	8	..	8
Ditto	6	..	8
Ditto	4	..	8
Ditto	2	..	8
Ditto	1	..	2
Ditto	0½	..	0

At this time, November 15th, the effect of the waterings is still very conspicuous, the grass so treated being not merely darker but thicker, and three times longer on the best lots than on the adjoining turf.

Having thus discovered that nitric acid did act, and having ascertained the safe dose, I made two further trials, which included the alkalies separately, soda and potash, and also included ammonia to serve as a further test. In both trials the nitric acid acted decidedly. The alkalies, neither of them, produced even a trace of effect on the colour or on the growth of the grass:—

October 3.

Manure employed on Area of 5 square feet.	Quantity in Drachms.	Water in Pints.	Effect on Grass, perfection being taken at 10.
Nitrate of soda . . .	6	3	10
Nitric acid	4	..	8
Ammonia†	1⅔	..	5
Soda†	1⅔	..	0

October 4.

Nitrate of soda . . .	6	1½	10
Ditto	3	..	5
Nitric acid	2	..	7
Ammonia	1⅔	..	5
Potash†	3	..	0

* The drachms express, of course, the *weight* of the dry salts and the *measure* of the liquid acid.

† The carbonates of ammonia, soda, and potash.

The success therefore of the experiment was complete. The question being whether in saltpetre the alkalies or the acid contain the active principle, we have found upon a given soil the alkalies absolutely inoperative, while the acid has acted exactly like saltpetre itself and like ammonia. The action, indeed, does not follow any precise proportion to the quantity of nitric acid employed, but neither does it to the quantity of saltpetre. For both, as is the case with other manures, there is no doubt a maximum, to exceed which is useless and may even be prejudicial. But the action of the nitric acid was palpable, unfailing, and indeed very powerful. On many other parts of the grass-plot sprinklings of the diluted acid were poured, and were everywhere followed by a dark luxuriant vegetation. We may now therefore assume, with unhesitating certainty, as a great law of nature, that **substances strengthen vegetation mainly by their contents of nitrogen.**

This law sheds at once an harmonious light over the scattered facts which the unlettered husbandman has learned while still groping in the darkness of practice. If we look at the practice of manuring only, we find the most dissimilar substances applied to the soil—sprats or sticklebacks here; woollen rags, or shoddy, or hornshavings there; seaweed in another place, rapecake elsewhere. All these refuse matters, however, agree in containing *undeveloped* Nitrogen. Again, lupines, sown for the purpose, are in some countries ploughed in as manure, as are the remains of the clover-crop, both also containing Nitrogen undeveloped. In dung and in liquid manure the nitrogenous matter is *partly* combined with hydrogen, and has thus become ammonia. In other manures, as soot and gas-water, the pungent smell shows the *full* development of ammonia. Again Nitrogen may combine not only with hydrogen to form an alkali, ammonia, but with oxygen also to form an acid. That acid, in whatever combination, whether with potash, soda, or lime, is equally active; nay, as I have now shown, the consuming liquid itself is able to nourish the tender herbage of the green lawn. This same law explains moreover not fertilizing substances alone, but the fertility of the soil itself also throughout many wide tracts. Not only are the plains of Hindostan made fruitful by their native saltpetre, but the famous Tchornoi Zem, or black earth, which over wide tracts around Tamboff bears wheat crops in endless succession, and will not endure to be dressed with dung, has been found by late analysis* to be charged with nitrogenous matter, the remains of living organisms. Nay, when poets† tell us that battle-fields

* See M. Payen's analysis in Sir R. Murchison's account of the Tchornoi Zem, Journal iii. 132.

† "Nec fuit indignum superis bis sanguine nostro
Emathiam et latos Hæmi pinguescere campos."

"Emathia,

are rendered fertile for ages by patriot blood, we now understand scientifically this mournful memorial of human slaughter.

The admission of this truth has been delayed, according to Dr. Wilson, by "a reluctance in teachers of chemistry to admit two sources of nitrogen for plants, because it complicates their statements and multiplies their formulæ." The awkwardness is no doubt the greater, because the substances in question are not merely duplicate, but of opposite natures; the one, ammonia, being alkaline, and the other acid. Dr. Wilson suggests, not unjocosely, that the exclusive advocates of ammonia should assume the conversion of the nitric acid into ammonia before any organic compound is developed, and thereafter carry out the ammonia theory as before.* On the other hand, the distinguished chemist of Cirencester College, Dr. Voelcker, informs me that, in his opinion, "plants in general are *more* dependent upon nitric acid, as the source from which they derive their nitrogen, than upon ammonia." Within soils containing lime—and most soils contain lime, either natural or applied—Dr. Voelcker thinks that nitrogenous manures are converted not into ammonia, but into nitric acid. Now, of the manures above enumerated, two only are strictly ammoniacal, namely, soot and gas liquor. Of the others, in some, such as fish, rags, &c., the Nitrogen is as yet undeveloped, and may therefore assume in the soil the form either of ammonia or nitric acid, we know not which. In fresh dung and urine it is *mainly* undeveloped. Even in guano, Dr. Voelcker has found it developed only to the extent of one quarter. But in all these cases he conceives the undeveloped Nitrogen to be changed within suitable soils into Nitric acid. Further investigation is evidently required. The general law is established as to nitro-

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"Emathia, Heaven decreed, was twice imbrued,
And Hæmus' fields twice fatten'd with our blood."
Georgics: WARTON.

Lucan also, in speaking of the same battle-field of Pharsalia, mentions the darker hue imparted to the young corn by past bloodshed, as well as the remains of fallen warriors turned up by the plough :—

"Quæ seges infectâ non surget decolor herbâ?
Quo non Romanos violabis vomere Manes?"—*Pharsalia,* vii.

* Dr. Hartstein, Director of the Prussian Agricultural College at Poppeldorf, in an able work he has just published on the 'Improvements of English and Scotch Farming,' argues earnestly for this previous conversion of nitric acid into ammonia. "This occurs," he says, "as follows :—The hydrogen liberated by the decomposition of organic substances, when it meets the nitric acid of saltpetre, not only withdraws from it oxygen, and so forms water, but, further, hydrogen in the *nascent* state combines with the nitrogen, forming ammonia, the food of plants. In thus explaining the beneficial action of saltpetre, we find no scientific contradiction. The transformation of nitric acid into ammonia by hydrogen, when this latter substance is liberated from combination, and comes simultaneously into contact with nitric acid, is a well-known fact."—*Fortschritte der Englischen und Schottischen Landwerthschaft,* von Dr. Edward Hartstein. Bonn. 1853.

genous matters: but whether they act upon plants in two forms, Ammonia and Nitric acid, or whether by some secret of nature either of these forms is transmuted into the other before it serves the purpose of vegetable nutrition, is a question reserved for the future decision of agricultural chemists.*

Singularly indeed, while we are discussing the question, it has been discovered at Paris that nature supplies to plants both forms of nourishment indifferently in every shower. Our English chemist Cavendish showed in 1781 that the electric flash *might* produce Nitric acid in the atmosphere. Liebig has since ascertained the actual existence therein of Ammonia. Monsieur Barral, having examined the rain-water collected at Paris last year and the year before, has found in every shower an amount of each substance, reaching in the course of a year the following quantities severally per English acre: †—

			Nitrogen.
	lbs.		lbs.
Ammonia	12·29	=	10·69
Nitric acid	41·24	=	10·12

Still this large amount of manuring substance might be derived by the atmosphere of Paris from the smoke and the fœtid exhalations which float above every great capital, and much doubt was accordingly felt by continental chemists on the whole result of the investigation. It seemed desirable, therefore, to repeat the experiment in pure country air. Accordingly rain-water was collected by me last October at this place, which is remote from any large town, except Oxford, from which the wind did not blow while the showers took place. It was analysed by Professor Way; and, supposing our annual fall of rain to be 28 inches, the amount of manure yearly poured down from the clouds on our soil would be larger than even at Paris. For it would stand thus:—

			Nitrogen.		Nitrate of Soda.		Guano without Phosphates.
	lbs.		lbs.		lbs.		lbs.
Ammonia	28·59	=	23·54	=	$159\frac{3}{10}$	=	164
Nitric acid	68·91	=	17·88	=	121	=	$124\frac{6}{10}$
Annual downfall of manure per acre			41·42	=	$280\frac{3}{10}$	=	$288\frac{6}{10}$

It appears that in a year of ordinary rain the skies give us

* For a very instructive inquiry into the difficult subject of nitrification, see 'Expériences Chimiques et Agronomiques, par F. Kühlman. Paris, 1847.' This work also contains a series of experiments proving the nitrogenous hypothesis of manures; and also a direct experiment establishing the action of nitrate of lime, which had not previously come to my knowledge.

† The figures of M. Barral are so corrected by Dr. Wilson.

Ammonia and Nitric acid equal to a full dressing of Saltpetre or Guano. Much of each, especially the Ammonia, is lost, perhaps, by exhalation from the surface of plants or of the land after slight showers. Enough, however, of both must remain to account for the luxuriant growth which sometimes seems to follow a thunderstorm, and also to illustrate the Psalmist's expression that the clouds drop fatness. This atmospheric distillation may also account for the permanent fertility of downs from which the sheep have for centuries been removed every night—in some degree for the benefit conferred by rest upon fallows—partially even for the remarkable repetition of wheat-crops at Lois Weedon, if we suppose that the constant stirrings practised by Mr. Smith enable the soil to absorb the pluvial Nitrogen that might otherwise escape by evaporation. In any case, this large discharge of Nitric acid as well as Ammonia is rendered important by the direct evidence now attained for the action of that acid upon vegetation.

Nor will our better acquaintance with Nitric acid be limited, I trust, to the theory of agriculture, or remain a dead letter, without effect on our practice, for we now know with certainty the efficacy of the Nitrates. But one great chemical problem of agriculture is the prevention of waste in dung-making; yet the attempts to fix the ammonia of dung have not been very happy. While some methods have not fixed it at all, others have cost in fixing it more than the result, if attained, would be worth. The favourite proposal has been the formation of sulphate of ammonia, which, under ordinary circumstances, is a fixed salt. But an experiment made last spring on this farm will show how little we can depend on the fixity so dearly obtained.

A ten-acre piece of oats, looking last spring very badly, was dressed on one side with nitrate of soda, and with sulphate of ammonia upon the other side, a blank space being left in the middle. Since the nitrogen in the ammonia and in the nitrate were in the proportion of 20 and 15 respectively, I made no doubt that, as equal quantities, 6 stone of each per acre, were used, the ammonia would yield the bulkier crop. On the contrary, while the nitrate, though a moderate dose, gave an increase of 18 bushels per acre, forcing the straw, too, a foot higher, no difference at all could be seen between the yield of the unmanured and of the ammoniated land. This unaccountable result has been cleared up, however, by Dr. Voelcker, who informs me that sulphate of ammonia had equally failed on the Cirencester farm; that he had often remarked a pungent odour on the land where it was used, and has little doubt that this salt, however carefully fixed, had been decomposed again and dissipated by the natural lime of the soil.*

* On other soils sulphate of ammonia has been found operative, but it is

On the other hand, great fault has been found with our ordinary mode of making dung by laying it up in heaps. It has been said that when first put together these heaps show the presence of Ammonia by the pungent smell that escapes from them, but that after a few months their scentless state proves them to have become little better than dead woody fibre. Still it was clear that this apparently inert matter, though it gave forth no odours, had a powerful effect upon the farmer's crops, and I have long suspected that dunghills might contain Nitre. Mr. Nesbitt informs me that by chemical analysis he has repeatedly found nitrates in ripened dung. The alkali required might be furnished by the potash of the decayed straw. But he has also found, what is a very curious chemical fact, that whereas, for forming a salt, some alkali or other is required to combine with the acid, and whereas further, Nitrogen, when liberated from decomposing matter, may become either Nitric acid or Ammonia, which is an alkali, *both* Nitric acid and Ammonia are in fact sometimes formed in fermenting manure at the same time, for the very purpose, as it were, of combination; for Mr. Nesbitt finds Nitrate of Ammonia * in dung-heaps. This is certainly a remarkable effort of nature to prevent waste of fertilizing materials, but a lesson which in our domestic arrangements we can hardly be said to obey.

Again, no farming practice has been more decidedly blamed than the west country method of mixing lime with the dunghill, because lime decomposes salts of ammonia. It was forgotten, however, that in fresh dung the ammonia is *not yet formed*, while the undeveloped nitrogenous matter contained in the dung may be most effectually fixed by the lime—may become nitrified through the mixture, exactly as in the French nitre-beds, by which saltpetre was produced during the late war for the manufacture of gunpowder.† So cautious must we be in drawing chemical inferences for farmers without careful and direct experiment.

In compost heaps, too, nitrates are doubtless produced, and the suggestion of Mr. Nesbitt is well worth consideration, that in making our dung we should no longer aim at fixing ammonia, which eludes our grasp, but at forming nitrates in accordance with the practice of husbandry and the explanations of science. Dr. Voelcker's opinions point the same way, and, in justice to him, his views ought to be presented as communicated to me for my own information.

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evidently not a manure which can be adopted anywhere without previous trial, to be used upon the *surface* of land.

* See Mr. Nesbitt's letter appended to this paper.

† According to the prevalent opinion caustic lime would decompose the urea contained in fresh manure, but Dr. Voelcker informs me that experiment leads him to an opposite conclusion.

"I am glad that you are advocating the use of nitrate of soda in agriculture, for I have long entertained the opinion that the functions of the nitrates, in relation to the nutrition of plants, are of the highest importance, and that the more liberal application of nitrate of soda will be a great boon to the farmer.

"It appears to me that plants in general are *more dependent on nitric acid, as the source from which they derive their nitrogen, than upon ammonia.* Already, four years ago, I came to the conclusion that ready formed ammonia ought not to be applied to calcareous soils, and have recommended accordingly to bring the farmyard-manure on such land as fresh as possible; and in artificials, to supply the place of the ammonia by *nitrates.*

"I have been led to this conclusion by the following theoretical reasonings, which I had occasion likewise to observe confirmed by local practice.

"Lime readily displaces ammonia from its salts, and being volatile, we can understand that much of the most essential fertilizing constituents of well fermented dung will be lost when it is applied to a calcareous soil.

"If, on the contrary, organic nitrogenized matters are decomposed in contact with strong bases, such as lime or potash, the nitrogen they contain is converted into nitric acid, and not, as usual, into ammonia. *Fresh* dung, in which the greater part of the nitrogen which it contains is not yet changed into ammonia, as appears to me, should be employed on calcareous soils; because it is highly probable that the lime in such soils will convert the nitrogen of the nitrogenized substances of the manure into nitric acid—a compound which, in combination with bases, appears in many circumstances to exercise even a more powerful invigorating effect than ammonia itself. In confirmation of these views I have frequently observed that guano shows a much more marked effect on other soils than very calcareous ones. On our own farm I have frequently observed a very powerful smell of ammonia, especially in dry weather, in walking over fields which had been top-dressed with guano.

"Some years ago we used sulphate of ammonia on several thin stony calcareous soils, and portions of the fields were left undressed, in order to observe any difference in the crop; but not any difference could be seen in the portions of the fields which were not manured with sulphate of ammonia. The smell of ammonia, on the land on which sulphate of ammonia was employed, was very strong indeed, and I have little doubt that almost all the ammonia contained in the salt has been driven off by the lime in the soil, and that for this reason no effect in the appearance of the crop has been observed.

"That guano still exercises a very powerful action on calcareous soils need not astonish us, for although a portion of nitrogen, contained in it in the form of ammonia, is driven off when guano is employed on such land: by far the greater quantity of nitrogen in guano exists in it as uric acid and other organic compounds, which, in contact with lime, will give rise to the formation of nitrates on their decomposition. Besides, guano contains phosphates and salts of potash."

Our acquaintance then with the main law of manures stands at present as follows:—The Nitrogen of most manures is committed to the soil in a neutral state, capable therefore of uniting either with Oxygen to become Nitric acid, or with Hydrogen to become an alkali, Ammonia. Some few manures contain Ammonia ready formed, some other few Nitric acid. It seems clear that the neutral nitrogenous matter is converted into Ammonia or into Nitric acid before it is absorbed by the plant. So that we have only two alternatives to consider, not three. But it is uncertain as yet whether plants can feed indifferently on each of the two substances, or whether one of these is first transformed

into the other; whether, that is, the acid is changed into the alkali, as Dr. Wilson deems possible and Dr. Hartstein asserts, or whether what appears a more easy transformation takes place, and Ammonia is changed into Nitric acid.

This scientific question between Ammonia and Nitric acid assumes indeed further a very practical commercial shape. For, as is well known, our main foreign supply of manure reaches us from the rainless side of South America, in rival cargoes of guano and cubic saltpetre, the former of which, as it happens, is ammoniacal, the other a nitrate. Now this rivality is most important, since the guano trade is a monopoly of the Peruvian Government; and, even were the trade open, there is a doubt how long it would last, for in that free republic, as we are told, Don Domingo Elias was sent to the gaol of Callao last summer for alleging that the supply of guano would be worn out in nine years.

This sensitiveness of the Peruvian rulers in itself raised suspicion; and authentic intelligence has just reached our own Government from the admiral in command on the coast of Peru which renders the whole question of monopoly less important, inasmuch as, if Admiral Moresby's report be accurate, the entire trade may come to an early end from exhaustion of the material.

According to a semi-official statement of the Peruvian Government,* the total deposits of guano in their territory amounted nearly to 27,000,000 tons, which, at a yearly export of 200,000 tons, would last more than a century. It was apportioned as follows:—

Northern District	854,000
Middle ditto (*Chinchas Islands*) . .	18,250,000
Southern ditto	7,621,000
Total	26,725,000

But Admiral Moresby states that the larger of these Spanish numbers is reduced by English survey (no unusual occurrence, by the way, in the Peninsular war) from 18,250,000 to 8,600,000 tons. Furthermore, it appears that, of this reduced quantity, only one-half is by its quality fitted for English consumption. This reduced amount is also now being exhausted more rapidly by an active demand from the United States; for the American ships loading at the Chinchas actually exceed the British in tonnage. In short, Admiral Moresby, in his official despatch, comes to the conclusion that, "at the present average rate of exportation, the islands would be exhausted of the guano that would pay freight, or be saleable, in the English market, *in eight or*

* Correspondence on the Guano Islands, presented to the House of Commons, May, 1852.

nine years." It is true that the Admiral's survey has been limited to the middle district, the Chincha Islands, and that, according to the Peruvian government, the northern and southern districts contain 8,000,000 tons of guano besides. But when we have made due allowance for the airy amplitude of Spanish arithmetic, and also a deduction for inferior *quality* from the gross *quantities* which English officers may find in existence, it is to be feared that those other districts may not add many years to our lease of this valuable manure. The prospect is formidable, since 150,000 tons of guano are now imported yearly, and nearly a million and a half sterling expended by spirited English and Scotch farmers, whose management is entirely dependent upon this foreign manure. We must now, therefore, look the difficulty in the face and prepare for the emergency. A fresh source of supply is of course desired, and our vessels are on the look-out for one; but the samples of new guano lately brought home have been found deficient in the essential ingredient Nitrogen. One guano, indeed, met with, how extensively seems doubtful, in island caves of the Indian Archipelago and on the coast of Tenasserim, and produced not by seafowl but bats, does contain Nitrogen, not indeed as ammonia but as *saltpetre.* This *transmuted* guano, used successfully in the spice plantations of Penang, contains a warning, as it were, that, instead of merely searching the seas, with whatever hope, for more guano, we should at once recognise the most valuable ingredient of guano as it is found for the digging on the vast salt-plains of Tamarugal, at the foot of the Andes. The supply, too, of Nitrate is likely to increase, not diminish, for, since attention was drawn in this Journal last winter to its manuring efficacy, an engineer has proceeded from England to construct a railway from the port of Iquique. It may be useful then to conclude this short notice by a comparison between guano and cubic saltpetre, as applicable and applied to particular crops; and if any one imagines that guano belongs only to amateur farming, Mr. Stevenson will tell him that in East Lothian* the money expended on portable manures may be taken at 12*s.* to 18*s.* per acre on the whole cultivated land of the county, that from 400*l.* to 600*l.* is a *common* yearly expenditure for guano on individual farms, and that "the largest acreable produce known to him is from land naturally very inferior, a cold retentive clay resting upon the coal formation"—the worst of all subsoils—20*s.* per acre rent being paid to the landlord, but to the guano-merchant 46*s.* per acre, or *a thousand pounds yearly.*

In comparing the two manures we must not, of course,

* See Report on East Lothian in the present number, p. 304.

forget that, besides Nitrogen, guano contains phosphorus and potash. These ingredients, however, can be easily added to each ton of saltpetre, if wanted, at a cost of 1*l.* 13*s.* 9*d.* for phosphorus, and 14*s.* 8*d.* for potash; but the potash I believe would be rarely, and the phosphate not often, required.

Large as is the importation of guano, the crops to which it is applied are few, and the comparison of it with nitrate of soda as applied to those crops, need not be tedious, for guano is used chiefly as follows:—First, as a top-dressing for grass; next, drilled with wheat in autumn, or sprinkled over wheat as a top-dressing in spring; lastly, for turnips.

The practice of top-dressing grass can hardly, indeed, be called a *practice* as yet. The careful experiment directed by H.R.H. Prince Albert to be made on the Windsor Farm, and recorded in this Journal,* while it proved that the use of *both* the leading nitrogenous manures is profitable upon grass, gave the advantage to guano. This advantage might have been accidentally due to the heavy rains which, prevailing at the time, may have washed down the nitrate below the roots of the grass. But information which has just reached me from an eminent Scotch farmer, Mr. Hope, of Fenton Barns, confirms the Windsor experiment. Mr. Hope's opinion derives great weight from the extent of his experience, for he occupies 660 acres, and states moreover that, *unless portable manures are applied at the rate of 1l. per acre over the whole farm, he cannot continue to farm at a profit.*† He writes to me thus:—

"For many years I have been in the habit of applying nitrate as a top-dressing for clover and rye-grass, to be cut as green food and for hay. I generally sow it broad-cast on the grass early in April. I have found that 180 lbs. per imp. acre was a fair allowance, but that it paid better, from a heavier crop being obtained at less expense, to give only 90 lbs. nitrate and 180 lbs. of Peruvian guano, *this being also better than double the quantity of guano by itself.*"

This result of Mr. Hope's experience is intricate, but appears to show on the one hand that, on his particular soil, the nitrogen of the saltpetre requires to be aided by the phosphates, perhaps even by the potash contained in guano, and to prove on the other hand that a *small* dose of those salts is sufficient, while the superior *fixity* of the nitrogen contained in the nitrate compensated its greater *quantity* in the guano. For we know that in dry weather a total loss by surface exhalation has sometimes attended the use of guano; and as upon grass-land guano of course cannot be harrowed in, it would appear thriftier to use nitrate only, with the addition of superphosphate, and, if re-

* Journal of Royal Agricultural Society, xiii., p. 347.

† See Mr. Stevenson's account of Mr. Hope's farm in the present number, p. 317.

quisite, potash, for grass; we have striking evidence from Scotland for the profitable application of nitrate even *singly* to grass-land. Thus Mr. Main, of Mid-Lothian, in his Prize Essay,* tells us :—

"Top-dressing on grass, whether for hay, soiling, or pasture, is of immense advantage. A remarkable instance occurred in my own experience three years since. A field of 15 acres had been laid to permanent pasture some six years before. It is not naturally a grass soil, indeed the very reverse. For three years, however, it yielded well and kept a large amount of stock. In the fourth it began to fail, the fifth was still worse, and in the sixth it may be said that 12 cows *starved* on it. In the seventh it was top-dressed with a ton of nitrate in April, and the results were astonishing. The stock pastured on it that year was 13 milk cows (2 with calves suckling), 5 stirks, 3 colts, and at intervals 60 sheep. I have continued to benefit by this experience. A large amount of roughness (rough grass) was left for wintering ewes, which I could not in the two previous winters fold in the same field."

On the average then of seasons nitrate, aided by superphosphate if need be, appears preferable to guano for top-dressing grass, and in this application of it no risk can arise from over-luxuriant growth.

Not so in its use upon wheat, for which purpose a combination with salt can alone render it safe. But there are two modes of supplying wheat with pulverized manures—autumnal drilling and spring top-dressing. An experiment tried here this year throws some light upon both methods, and may be the more useful as involving the total failure of one.

The trial ground had been purposely exhausted by white crops for three previous years. Four different manures were drilled with the wheat in the autumn; one-half of each lot was dressed with nitrate and salt, at two dressings, in spring. The produce was threshed out on the field, separately, after harvest. Contrary to the experience of others, and to my own upon the same land, none of the drilled manures took any effect. The soil is a sandy loam, and they must all have been washed down by the unusual rains. But the spring dressing with nitrate took a singularly powerful effect, as the following table will show:—

Turns of the Drill.		Manure. Cwts.	Yield on Undressed $2\frac{1}{2}$ acres. Bushels.	Yield on Top dressed $2\frac{1}{2}$ acres. Bushels.	Increase by 2 cwt. Nitrate. Bushels.
10	Guano . . .	3	$6\frac{1}{4}$	13	..
10	Blood . . .	3	$6\frac{3}{4}$	$12\frac{1}{2}$	..
10	Rapedust . .	6	$4\frac{1}{2}$	$11\frac{3}{4}$	..
10	Nitrate . .	3	$5\frac{1}{8}$	$11\frac{1}{4}$	..
2	Nothing . .	0	1	$2\frac{3}{4}$	..
Five acres.			$23\frac{5}{8}$	$51\frac{1}{4}$	$27\frac{5}{8}$

* Transactions of the Highland Society, July, 1853, p. 16.

It will be seen that the *natural* produce of this land is very low—only 9 bushels of wheat per acre, and that owing to the season the drilled manures were all but thrown away. The profit by the top-dressing of nitrate was, on the contrary, exceedingly high. On about $2\frac{1}{2}$ acres of wheat, 2 cwt. of nitrate and 4 cwt. of salt, costing less than 2*l.*, gave about $3\frac{1}{2}$ quarters of grain, which at 57*s.* sold for nearly 10*l.*—in exact figures 9*l.* 17*s.* Last year I ventured to say that if nitrate could be reduced in price by *one-half*, a large additional home supply of wheat might be grown at 12*s.* per quarter. This year, at the *same* price of nitrate, these extra $3\frac{1}{2}$ quarters stood me in less than that sum. It is curious that poor land, producing merely 9 bushels per acre, was enabled by 90 lbs. of nitrate, costing with the salt 15*s.*, to grow 20 bushels per acre. So great an increase is however exceptional, nor would it be safe to take the average increase of wheat by the use of Nitrate at more than 6 bushels per acre, but the poorer the land the greater will be found its efficacy.

Being satisfied as to the superiority of nitrate to guano *as a top-dressing*, I have made no further comparative trial, but have been fortunate enough to receive from the high authority of Mr. Hope the following decisive experiment carried out by him in the two last seasons:—

"I have only applied nitrate for two years to wheat, and that after seeing the account of your own experiment in Mr Caird's English Agriculture. In April, 1852, I top-dressed wheat after potatoes; the soil a dry gravelly loam. At the time the wheat was not very promising in appearance. I sowed on part 1 cwt. nitrate mixed with 1 cwt. salt per imp. acre; on another portion 3 cwt. Peruvian guano was applied, and a part got nothing. The nitrate of soda soon took the lead, and kept it. A portion of each was threshed separately, when they were found to yield as follows; viz.—

Cwts.		Per Imp. Acre. Straw.	Wheat.
1	Nitrate of soda	$37\frac{3}{4}$ cwts.	53 bushels.
3	Guano	36 ,,	49 ,,
	Nothing	33 ,,	39 ,,

"In 1853 I tried the same thing on wheat after beans; I never, however, could detect any difference with the eye except where the crop got nothing, though in the former year the difference between the two manures could be seen at a glance; and having cut the crop with a reaping-machine, which rather intermixed the lots, I was prevented threshing them separately. I have bought 5 tons nitrate for next year, and mean to apply a portion to potatoes."

Here it appears that *three* cwt. of guano, costing about 30*s.*, were surpassed in 1852, and equalled in 1853, by *one* cwt. of saltpetre, costing with the salt but 18*s.* Indeed, guano is so liable to escape in dry weather upon a hot surface, that it cannot compete with nitrate as a top-dressing. For autumn sowing it is probably better than nitrate; but then the question arises, ought we

on *light* soils* to use at that season either one or the other? When we consider how soon the growth of autumn-sown wheat comes to a standstill, to provide it with manure, in the hope that the food may remain safe for its use in the spring, seems at best a venturous precaution, like placing beneath an infant's pillow the cates intended for its morning repast.

There remains only to be considered the application of guano to turnips, but here the comparison of the two manures is less easy, because a previous question arises whether either one or the other should be applied to turnips at all, or whether in the culture of those roots we should not rather rely upon bone-earth. From experience I have long done so on my own farm; there are on record experiments clearly showing that on some land superphosphate is not only cheaper than guano, but more effectual; and as the consumption of guano for this purpose is very great, especially among the spirited farmers of East Lothian, it will be worth while to recall one or two of those experiments, and first a very striking one made by Mr. Drewett, near Arundel:†—

	Weight of Turnips per acre.	
Purchased manure—	Tons.	Cwts.
None	5	18
3½ cwt. Peruvian guano	9	2
3½ cwt. African guano	13	1
Superphosphate from 6 bushels *calcined* bones	17	10

It is observable here that not only has the superphosphate excelled the guano, but the cheap African has surpassed the dear Peruvian guano, because it contains less nitrogen indeed, but more of the phosphates. Mr. Caird also states that the inferior and cheaper Bolivian guano is better for turnips than

* On strong soils the case is different, as the following experiment made by Mr. Caird at Baldoon, in the same wet autumn of 1852, clearly shows. The result was as follows:—

Experiment with Guano on Wheat sown after Fallow on drained alluvial Clay, the Guano (Peruvian) harrowed in with the seed, 20th Sept., 1852.

	Cost per Acre.	Yield in Bushels.	Increase.	Gain after deducting cost of Manure. Wheat at 7s.
	s.			s.
1. One acre without manure	..	35	..	..
2. „ 2 cwt. guano .	20	44	9	43

† Journal, vol. i. p. 582.—Each lot received also 20 bushels of dung, and 200 to 250 bushels of turf-ashes.

the Peruvian, the ground of that superiority of course being the same, the excess of phosphates in a given weight of Bolivian guano.

Mr. Lawes even found that where he had supplied his turnips with superphosphate all the nitrogenous manures he could add to that manure produced no increase in his crop.

	Nitrogenous Manures added.	Mean produce of Turnips per acre. Tons.	Cwts.
Phosphates, &c.	. . . .	12	8
,,	with 10 cwt. of rape-cake .	13	4
,,	with 3 cwt. sulph. ammonia .	12	5
,,	with 10 cwt. rape-cake, and 3 cwt. ammonia . . .	12	4

Still, though both experience and experiment in the South of England are in favour of giving phosphorus only to turnips, and of reserving nitrogen for the corn crop, it would be rash to assert that our northern farmers are wrong when they use guano, and deference is due to their experience also. We find, indeed, that ammonia sometimes thins the plants, and that it produces the growth of leaf rather than bulb. Possibly from our necessarily late season of sowing, that excess of leaf has not *time* to mature the weight of bulb, which the cooler skies of the north allow it to ripen by permitting an earlier sowing. Be that as it may, I thought it right to try nitrate upon turnips this year, in order to ascertain whether, in case of need, it might become a substitute for guano with this crop also. Guano itself, however, was not used in the comparison because that being a compound substance, the experiment would have been more complicated. All that I wanted to know was whether the nitric acid of the salt would act upon rootcrops like the ammonia of the birds'-dung, since if this were so the other constituents of guano might be easily added. The nitrate and the ammonia* were applied in equal quantities, and they acted exactly alike; so much so, indeed, that, though very small doses of each were applied through the water-drill, they both seemed equally to have killed all the seed. However, some stragglers came up, sufficient to fill the rows, which grew very slowly at first, but became luxuriant afterwards, and certainly would have gained bulk for another month if they had not been stopped by a November frost. No difference could be seen in the action of the two manures, and the test of weighing showed their effect to have been nearly identical.

* The sulphate of ammonia was used, and was well mixed with the soil, so that there was no risk of its escape by evaporation.

	Swedes per Acre.	
	Tons.	cwts.
No manure	16	8
Nitrate, 160 lbs.	20	8
Ammonia sulph., do.	20	1

The result of the whole comparison appears to be this. For grass-land, saltpetre is equal to guano if a small quantity of phosphates and perhaps of potash be added. For wheat it is probably inferior to guano if applied in autumn, because more liable to be washed down by rain, but preferable if used in spring, because less liable to evaporation in drought, and spring is apparently the best season for giving purchased manures to wheat. For turnips superphosphate is superior generally to either guano or nitrate, and has the great advantage over both that it can be used with the water-drill, and that, being so used, it gives us in the south a rapid growth which makes up for our late seed-time; but if nitrogenous matter be also required, we now know that nitrate can be spread broadcast over turnip-land as successfully as guano itself. We have therefore found a substitute for guano in the three great departments of husbandry, the culture of Grass, of Roots, and of Corn.

The comparison of nitrate with guano is even more important this year than it was a twelvemonth ago. Then our object was to lower the price of guano by bringing into competition with it another article not sold under monopoly. Now, the recent survey of the Chincha islands shows that we have to fear a rise in the price of guano preceding a total cessation of the supply. The possession, therefore, of an equivalent is more desirable, and now that we have found that equivalent, the increased supply of cubic saltpetre is more urgent, and to that point the enterprise of our merchants must next be directed. This salt we know occupies the surface of a plain 150 miles long, the Pampa of Tamarugal, separated by only 10 miles from the Pacific. Unfortunately, however, those ten miles wear so rugged a surface, that, although a railway is being constructed from the port of Iquique, to a height of 3000 feet inland, it cannot be continued to the refinery; so that the coals for refining the salt, and the salt when refined, must still be carried on the backs of mules to and from these southern Salitres. But to the north of Iquique is the mouth of the river Pisagua, which skirts the Pampa not very far from the northern Salitres, affording of course a level line for a railway in the direction required. On the south, again, the river Loa offers the same facilities, passing near some newly-discovered nitrate beds. All these sources, however, have unfortunately one common defect—they are subject to the same government which owns the guano islands, the government of

Peru. But Mr. Bollaert, our main authority, informs us that nitrate is also found higher up the river Loa in the desert of Atacama, which belongs, I believe, to the rival government of Bolivia. It is further stated, though in a less authentic manner, that saltpetre plains exist to the west of St. Luis de Potosi, in Southern Mexico, with water communication to the Atlantic. In all those remote regions inquiry has been set on foot through the resident consuls by Lord Clarendon, and their answers will be communicated to our Society; but in the mean while the Liverpool merchants, who have been naturally eager to share in the guano trade, should not neglect to make exertions of their own in these more promising fields. Whether they fetch us guano or nitrate, we are now assured that they supply our land with the same manure, differing indeed in name and in form, but identical in substance and virtue. Such is the solid result established by chemistry, and thus I hope to have made good what I ventured to assert in the outset, that abstract investigation may sometimes serve to guide us safely amid practical difficulties.

Pusey, *Dec.* 1853.

N.B.—The amount of Nitric Acid and Ammonia contained in rain must be regarded as open to future observation and correction.

APPENDIX.

To Mr. Pusey.

Dear Sir,—At your request I subjoin a few observations on the conditions required for the formation of nitrates; much regretting that, in consequence of the approaching publication of the Journal, I have not time to present the subject before you in a more perfect manner.

For some years, in my lectures, I have endeavoured to direct the attention of the farmer to the artificial formation of nitre, having felt somewhat surprised that its importance has hitherto been so generally overlooked.

I shall at present content myself with a brief explanation of the conditions under which nitrates are formed. Whenever animal or vegetable matter, gaseous, liquid, or solid, containing nitrogen, comes into contact with *mild* calcareous or alkaline earths, the mixture being moist, and so porous that the air can easily penetrate, after some time the nitrogen, under certain conditions of temperature, is acted upon by the atmosphere, is oxidized, and is converted into nitric acid, which at once unites with the calcareous or alkaline bases present in the mixture.

The temperature most suitable is from 58° to 68° Fahr., and the action ceases at 32° Fahr., the freezing point.

The instances of the oxidation of gaseous nitrogenous bodies are very common. The mortar of almost all old buildings, in any situation, contains a greater or less amount of *nitrate of lime*, the nitric acid of which is produced by the oxidation of ammonia, absorbed by the mortar from the atmosphere. Another example is that furnished by an experiment of a French philosopher, who suspended a piece of moistened and well-washed chalk over a basin of putrifying blood, and who, after the lapse of some time, detected easily the presence of nitric acid in the chalk.

The oxidation of liquid nitrogenous compounds is also of ordinary occurrence. The urine of any animal mixed with calcareous or earthy matter readily furnishes nitrates by oxidation; and even the urinary deposits of animals on

pastures in summer give rise to the formation of nitrates. The walls of stables and cowhouses, which by absorption have been moistened with urine, often give on their surfaces efflorescences of nitre.

The conversion into nitric acid of the nitrogen of solid animal or vegetable matters constantly occurs when these bodies are in contact with earthy calcareous matters. Even in the absence of calcareous substances nitric acid is formed in such common dung-heaps as consist merely of decomposing animal and vegetable matter; for one part of the ammonia produced by ordinary decomposition acts as the alkaline base to another portion, which by oxidation is converted into nitric acid. Nitrate of ammonia may always be found in dung-heaps. Nitrates are also present in all shallow wells adjacent to *church-yards*, and in those which derive their liquid supplies from strata into which cesspools empty themselves.

The proper conditions for the formation of *nitrates* are always to be found in well-drained and well-manured fields, particularly when they contain calcareous matter. One of the great uses of liming is to furnish the alkaline matter where it is deficient. In our laboratories we have examined a great number of soils, and in almost every instance have detected the presence of nitre.

In my opinion, a proper knowledge of the mode of forming nitre beds would be of considerable importance to the farmer; for by their use not only would he be able to conserve the ammonia of his manure when he had more of the latter than he could at once apply to the land, but by using the liquid manure from the tanks the necessary moisture would be given to the heap; and whilst the aqueous particles, so expensive to carry, would gradually evaporate, the valuable matters of the liquid would be retained in the compost.

The mode of making artificial nitre-beds has been shortly described in my lecture to which you refer. It is exceedingly simple. A layer of calcareous matter forms the base of the heap, and layers of horse-dung, cow-dung, carrion, or other similar matters, alternating with layers of marl, mortar, or *spent* lime, will constitute the nitre-bed. The mixture should always be kept moist with urine, or urine and water; but too much water, as from rain, would be injurious, and the heap ought therefore to be kept under cover. The compost should lie as loosely as possible together, that the air may be easily able to permeate the mass. The heap should be thoroughly incorporated, and lightly turned over once in two or three months. In from six to nine months it will be ready for the farmer's use. *Quick lime* ought not to be used in making nitre beds, as its first and most powerful action is to drive off the ammonia from the manure.

It must be understood that, by making mixtures calculated to give rise to the artificial production of nitrates, we have a means of preventing the loss of ammonia which takes place in a common dung-heap; and that, under ordinary circumstances, manures containing either nitrates or ammonia, without any important amount of other substances, are valuable exactly in proportion to the amount of nitrogen they contain. It may be necessary to mention that in soils and dung-heaps the nitric acid produced by oxidation of ammonia *is reconverted* into ammonia when putrefaction is taking place and *access of air is prevented*.

In conclusion, I may mention that I have analysed a portion of a large nitre-bed of about 40 tons, which was (about ten months since) made on the premises attached to the College at Kennington. Though the heap has been exposed to all the rains of the season, it was found that 1 pound weight of the compost contained 21 grains of nitric acid, which is equivalent to 34 grains of saltpetre. This is an amount much below what we should have found had we had the heap under cover.

I am, my dear Sir, yours very truly,

J. C. NESBIT.

College of Agriculture and Chemistry,
Kennington, Dec. 13, 1853.

XXV.—*On the Refuse of the Cod-Fishery of Newfoundland as convertible into a Portable Manure.* A Despatch from the Governor to the Duke of Newcastle.

My Lord Duke,—In reference to the circular despatch from the Right Honourable Sir John Pakington, dated June 26, 1852, addressed to my predecessor in this government, transmitting copies of certain papers containing information respecting the properties of guano and the means of obtaining a larger supply of that valuable manure, I beg leave to call your Grace's attention, and that of the Royal Agricultural Society, to the value and importance of the use of fish and fish-offal as manure, after having undergone a certain process of preparation for the purpose of rendering it portable to any distance, and of facilitating its application to the soil.

With this view I have the honour to transmit, for your Grace's information, a communication, at my request, from M. Gautier, Lieutenant de Vaisseau, on board the French war-steamer Veloce, now on this station, on the nature and properties of this description of manure, and on the mode in which it is capable of being prepared in order to render it portable and applicable in the same manner as guano.

In this island the manure universally applied to the soil is fish, consisting of the superabundant herrings and caplins in the process of decomposition, and generally without any earthy admixture; and the heads, bones, and entrails of cod-fish, after having been decomposed and formed into a compost with clay or peat-bog earth.

This manure, I learn, has, on trial and comparison, been found to be much more fertilizing than guano; and when applied to the thin, gravelly, unpromising soil in the neighbourhood of this town, yields crops of grass and potatoes which, in vigour of growth and productiveness, cannot be surpassed elsewhere. It is no less powerful when applied to oats, which, however, owing to the shortness of the season and the consequent uncertainty of the ripening of the grain, are but partially cultivated.

Still, however rich and fertilizing as a manure fish-offal may be when applied to the soil in even the crude state and unscientific manner in which it is used in this island, it could never become an article of export, and be made useful for agricultural purposes elsewhere, without undergoing a process of manufacture similar to that described by M. Gautier. In this latter condition it will be seen, from the analysis referred to in the accompanying paper, that it forms a product perfectly analogous to, and at least as rich as, if not richer than, the best Peruvian guanos.

Should further experience confirm the evidence of these results, there is no doubt that this island could supply a vast amount of the manure in question, affording at the same time an additional valuable article of export from this colony. There are many parts of the island and its dependencies from whence the fishing is extensively prosecuted, and where there is little or no agriculture, in which the manufacture of manure from the offal of fish at present thrown away as valueless might be extensively and advantageously conducted. The carcases of seals which are now abandoned and left upon the ice, the skins and fat only of these animals being taken on board the sealing vessels, might also, in the event of the failure of the main object of the voyage, be made available in the furtherance of the manufacture in question.

In submitting these observations to your Lordship's notice, it is due to Lieutenant Gautier, who has been for a long series of years employed on the Newfoundland station, under the French government, and has made himself generally acceptable to the subjects of both nations, to express my acknowledgments for the promptitude and courtesy with which he has placed at my disposal the valuable information contained in my letter.

I am, &c., KER B. HAMILTON.

Government-house, Newfoundland,
August 23, 1853.

On board the Veloce, St. John's,
Newfoundland, Aug. 8, 1853.

SIR,—It is perfectly understood that guano owes its efficacy to the large amounts of nitrogen and phosphates which it contains. It is simply the produce of decomposition, partly of the bodies of animals, but mainly of the dung of sea-birds. The decay, therefore, of such animals and of fish is the source of the virtues of guano.....If, then, we can obtain a considerable quantity of the flesh of fish, decompose, dry, and pulverize it, we may evidently present agriculture with a substance equal to Peruvian guano.

The results of the first attempts at such a manufacture, in 1851, have yielded, on analysis—

Nitrogen, per cent.	(12·00)
Moisture	1·00
Nitrogenous organic matter	80·00
Soluble salts—namely, common salt, carb. ammonia, and a trace of sulphates	4·50
Phosphate of lime and magnesia	14·10
Carbonate of lime	0·06
Silica	0·02
Magnesia, and loss	0·32
	100

It remains to inquire where and how are to be procured any large quantities of fish, or the remains of fish; and how they can be converted into powder? Now we know, from the experience of our fisheries, that 400 tons of fresh cod do not yield more than 120 tons of dried fish for exportation. The refuse of the fish, which constitutes about half its weight, are often thrown away (in curing) into the sea. The bones are cast back by the sea on the beach, where they form considerable heaps, accumulated for centuries. Without reckoning upon herrings and other fish caught for the purpose, let us only consider the quantity of refuse at our disposal. The produce of the cod-fisheries on the banks of Newfoundland amounts annually to about 700,000 quintals, of which 350,000 are cured, and the remainder rejected. If these 350,000 quintals were decomposed, pressed, dried, and pulverized, they would produce 100,000 quintals of a powder similar to the best guano, composed according to the analysis above given.

The experiment made at Kerpon on the detritus is not yet being carried into effect. The pulverization requires drying stoves and machinery for grinding the bones. No attempt can be more worthy of encouragement, though time is required to judge its commercial result.

I regret that I cannot furnish to your Excellency more minute details; but, as the undertaking is in its infancy, I am at liberty only to state the general process, which is to use all the refuse of the fish by stove-drying and grinding.

Such are the facts which you have called upon me to communicate, and which I have much pleasure in submitting to your consideration.

Accept, &c.,

To His Excellency the Governor. A. Gautier.

XXVI.—*On the Farming of Surrey.* By Henry Evershed, Albury, Guildford.

Prize Report.

The physical characteristics of the county of Surrey render it ill adapted for displaying the most improved systems of agriculture; and the same circumstances which have conduced to the varied beauty of its scenery have opposed insurmountable barriers to the adaptation of many of those modern improvements which have in certain districts diminished the cost of production.

The area of the county is 759 square miles, or 485,760 acres. The population, according to the returns of 1851, amounted to 684,805. The number of farmers is much smaller in proportion to the population than in most other counties, while the number of manufacturers is much larger. This may be accounted for not only as being a natural characteristic of the county, but also from the circumstance of the "Surrey side of London" being included in the estimate.

Surrey is divided geologically into three principal groups of strata:—

1st. The *Tertiary.*
2nd. The *Cretaceous*, overlying the Wealden.
3rd. The *Wealden*, which is most ancient.

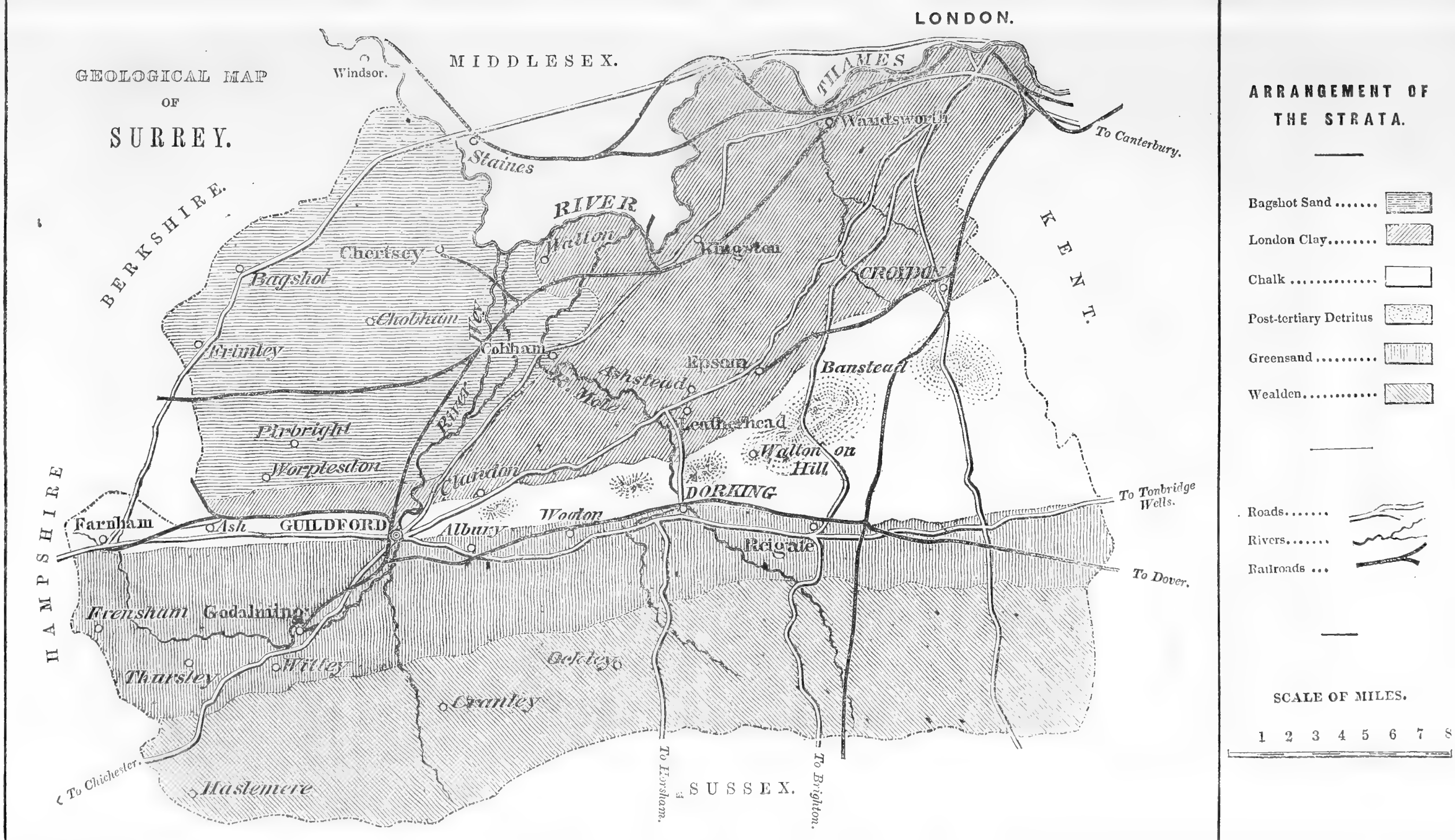
Commencing with the most recent deposits the above great divisions may be subdivided according to the character of their various strata. Thus:—

Tertiary .	Bagshot sand. London or Plastic clay.
Cretaceous	Upper chalk, or chalk with flints. Lower chalk, or chalk without flints. Grey chalk marl. Firestone and upper greensand. Gault, or Folkstone marl. Shanklin, or lower greensand.
Wealden .	Weald clay. Tilgate beds.

The *Bagshot sands* are so called from their being extensively developed around the town of Bagshot; they consist of the *upper* division on the north-western part of the county, extending from Bagshot Heath on the north to Romping Downs on the south, and stretching on the east nearly to the town of Chertsey—the *middle*, which underlies the former, and is exposed in belts which extend round the towns of Chertsey, Chobham, Pirbright, &c.—and the *lower*, which is bounded on the north by the last deposit, and meets the London clay at Walton-on-Thames, Cobham, Esher, and Ripley. The *London clay* is bounded on the north and west by the Thames and Bagshot sands, on the south by the chalk downs which it meets at Epsom, Clandon, &c. It also runs in a narrow strip from the west of Guildford to Ash, separating the Bagshots from the chalk. A detached portion of the tertiary formation is also found overlying the chalk; reaching as far as Guildford on the west, while on the east it occupies a considerable area, and is extensively developed in the neighbourhood of Walton-on-the-Hill.

The *Cretaceous formation* is the most prominent in the county, running through it from east to west. The chalk, its upper division, forms an elevated ridge well known as the North Downs, entering from Kent on the east at Merstham. Here the downs are of considerable breadth, viz. from 8 to 10 miles; they gradually become narrower till they reach Guildford, from which place to Farnham they form a narrow ridge called the Hog's-back, scarcely broader than the road which skirts its brow. The *firestone* and *upper greensand* which form the second division consist of impure limestone and calcareous sand. The *gault* is a narrow belt of clay separating the upper and lower greensand. On the eastern portion of the county it widens into considerable importance, while on the western it becomes narrow, occasionally disappearing altogether. The last and principal division between the chalk and the weald is the *Shanklin* or *lower greensand*, which on the eastern extremity seldom exceeds a mile in breadth, till at Dorking it gradually becomes wider, taking a south-western direction to Haslemere, and averaging in width 5 to 10 miles. The greensand attains a great height at Leith Hill, which is the highest point in the South of England, being 994 feet above the level of the sea.

It is hoped that with the aid of the accompanying map the preceding brief description of the various strata will be found sufficient as an indication of the position of those districts into which the county is divided by nature, and which will be



GEOLOGICAL MAP OF SURREY.
LONDON.
MIDDLESEX.
BERKSHIRE.
HAMPSHIRE
KENT.
SUSSEX.
THAMES
RIVER
Windsor.
Staines
Chertsey
Walton
Kingston
Wandsworth
CROIDON
Bagshot
Chobham
Frimley
Cobham
Wey
River
Epsom
Ashstead
R. Mole
Banstead
Leatherhead
Walton on Hill
Pirbright
Worplesdon
Clandon
DORKING
Wooton
Farnham
Ash
GUILDFORD
Albury
Reigate
Frensham
Godalming
Thursley
Witley
Ockley
Cranley
Haslemere
To Canterbury.
To Tonbridge Wells.
To Dover.
To Chichester.
To Horsham.
To Brighton.
ARRANGEMENT OF THE STRATA.
Bagshot Sand
London Clay
Chalk
Post-tertiary Detritus
Greensand
Wealden
Roads
Rivers
Railroads
SCALE OF MILES.
1 2 3 4 5 6 7 8

hereafter more particularly described in relation to the character of their soil and the peculiarities of their culture.*

The topics put forth for the notice of competitors are the following:—

"1. *The character of the soils and subsoils of the county.*"

"2. *The use of lime as a manure, to what soils (if any) it is confined, and whether its employment is at all diminished by high farming.*"

"3. *Interference of small inclosures with improved husbandry.*"

"4. *Effect of soil on the growth of timber trees.*"

"5. *The suitableness or otherwise of the farm buildings to improved husbandry.*"

"6. *The extent of underdraining effected in the county.*"

"7. *Improvements made since the Report of William Stephenson in* 1813, *and to what extent still required.*"

The information upon these various topics will necessarily be scattered over the whole of the succeeding pages, but for the greater convenience of the reader each will be discussed as far as is possible under its separate head.

"1st. The character of the soils and subsoils of the county."

As may be supposed from the number and proximity of the various strata, the soil is extremely various; the most extensive area of land of a tolerably uniform character is in *the Weald*, which occupies the southern portion of the county, on the borders of Sussex, and forms a strip varying from 3 to 6 miles in width. It is well known as a pale, stiff clay, with a subsoil similar in character, and which requires a long exposure to the atmosphere, and frequent tillage, to render it productive.

Running in a line nearly parallel with the Weald is the range of chalk downs, but between them is a tract of soil formed by the outcrop from the chalk of the lower members of the cretaceous formation, viz. the upper and lower greensand and the *galt*. The latter, as has been already noted, forms a strip of insignificant breadth; it is an exceedingly tenacious clay, generally of good depth on a subsoil of blue clay, bearing large crops of wheat and beans, and luxuriant oak and elm timber; it

* For a more detailed account of the geology of this part of the country than the limits of the present essay or the capabilities of the author will admit, the reader is referred to the notices which have appeared in the Transactions of the Geological Society of England (see vol. iv. 2nd series, 'On the Strata below the Chalk,' by Dr. Fitton), and to the 'Outlines of the Geology of England and Wales,' by Messrs. Connybeare and Phillips, 1 vol. 8vo., 1822; and to the numerous other geological works, where an account may be found of those wonderful revolutions which have laid bare the ancient deposit of the Wealden, and elevated the superimposed chalk-formation to its present position.

is naturally stiff and wet, and as from its position it invariably occurs on farms, the principal portion of which is of a light loamy, or rubbly nature, its management with respect to drainage, &c. is frequently neglected. The galt is capable of the greatest improvement by draining, and may then be ranked as some of the finest and most productive land in the county.

The Lower Greensand forms one of the most picturesque districts in Surrey; the abrupt character of the surface however, and the great and sudden changes in the quality of the soil, have greatly diminished its importance as an agricultural district: the soil varies from a sharp sand to the richest loam. Upon almost every farm, and often in the same field, land is to be found varying between the two extremes; the best land lies generally in the low ground, while the brows are frequently too poor to be cultivated, and have for the most part been sown with gorse, or planted with fir.

The Chalk Downs have a thin flinty soil, covered with a short turf; they are in most instances cultivated as far up their base as circumstances will permit; the land under the downs is of a thin rubbly nature, gradually becoming deeper, until it merges into the sands and loams below.

The Bagshot Sands vary from the black sand of the heath to the deep gravelly loams and heavy land in the neighbourhood of Chertsey.

The London Clay is deeper, less tenacious, and more productive than the clay of the Weald.

The Tertiary series, which overlies the chalk at Walton-on-the-Hill, Banstead, and to a less extent nearer Guildford, consists of flinty clays, loams, and heaths.

The preceding is a brief notice of the principal deposition of the soils of the county; at the junction of the various strata a soil is produced partaking of a calcareous, loamy, or heavy nature, as the case may be; while on the banks of the Thames and in some few other localities, an alluvial deposit is found.

A more detailed account of the character of the soils will be given when we come to a description of the farming of the different districts.

The soils of the county of Surrey are so various and unequally distributed that it would be impossible to find any very extensive tract of land of an uniform character. In noticing the various agricultural districts the writer will strictly adhere to the geological divisions, and will endeavour to give as clear an idea of the capabilities of the soil, and the modes of farming, as the variety of the subject will admit.

The Bagshot Sands.—A considerable portion of this formation is included by the sands of Bagshot Heath, but it must not

be supposed that the whole of this district is of a similarly poor nature; in many instances the land is of the best description, and except on the worst sands it is generally of a useful kind. One locality which demands particular notice is that of Chertsey; around which town a deep strong loam is found, the subsoil being gravel, or in some instances clay. The greatest portion of meadow-land is found on the alluvial soil of the Thames; the rents and the rate of labour are high, varying from 4*l.* for meadow and 3*l.* for arable, to 1*l.* per acre; rates are about 3*s.* 6*d.* in the pound, tithes 6*s.* per acre, but most of the land is tithe free: wages for able-bodied men are 11*s.* to 12*s.* per week.* As there is nothing distinct in the farming to separate it from the surrounding neighbourhood, the description of the whole district under consideration will now be continued.

The land may be described as being generally easy of cultivation, and, when well farmed, producing usually good crops, but liable in a dry season to be much injured by drought. Poppies, summer weeds and couch spread fast, though but little labour is required to get rid of them. The soils vary from a good dry loam, capable of bearing every kind of corn and roots, to the sharp clean blowing sand of the upper division, fit only for the growth of rye and inferior turnips.

The greatest improvement which suggests itself in this part of the county is in the farm buildings: they are frequently inadequate and out of repair. All the operations in the tillage of the land, here as throughout the county, are performed well and efficiently; the better construction and centralization of the buildings are improvements which must necessarily be the work of time, and it is hoped that no opportunity will be lost for making these changes.

The system of repairs is the same as in other districts, the landlord finds materials, the tenant labour; the same is the case in draining. The size of the farms varies greatly; there are many small holdings of from 50 to 100 acres, the generality varying from 200 to 400 acres. Some of the farms are held on lease of 7, 14, or 21 years, but most of them are subject to one or two years' notice. Rents vary from 10*s.* to 30*s.* per acre, tithes about 5*s.* an acre, rates 2*s.* to 3*s.* in the pound, wages 9*s.* to 10*s.* a week; the rent of cottages being 3*l.* to 4*l.*

Horse and hand threshing machines are occasionally used, but not to great extent.

The breeds of sheep are principally the Hampshire Down, or horned Somerset and Dorset. It is common to purchase ewes at

* Since the writing of this Report in February, 1853, wages have risen considerably.

Appleshaw or Andover fairs, and to sell them off fat after lambing: they are kept as much as possible on the leys and pastures, turnips being injurious for them till after lambing, when they are folded on turnips, and receive hay, chaff, and oilcake; the lambs being allowed to run through the wattles into the feed, where they have as much oilcake as they will eat. Oxen are purchased at the autumn fairs of Blackwater, Kingstone, and Knap Hill, and are in general Devons and Welsh. Pigs are of the Berkshire or Chichester breed, and are frequently bred on the farm.

The system of cropping most followed is the four-course, that being considered the rotation which in the long run is best adapted to the land, and therefore most profitable to its cultivator, being the one which commands the greatest produce consistent with keeping up the fertility of the soil. It is impossible to lay down any system whatever, which shall hold good under all circumstances, and there are often cases when a departure from the above course becomes both judicious and necessary. Upon this subject no opinion will be offered here, it being considered that the object of these Reports is to give an accurate description of the different modes of farming practised in various localities, that the reader may make his own comparisons and draw his own conclusions therefrom.

In the following particulars of the mode of tillage too great diffuseness of description will be avoided, that the Report may not be swelled by unnecessary details. The common course is:—

1, Turnips; 2, Barley; 3, Seeds; 4, Wheat.

A clear fallow through the winter is seldom taken on the light land of tolerable quality; a portion of the wheat stubbles being ploughed up and sown with rye, vetches, trifolium, or stubble turnips. The "seeds," which form the third year's crop, are a mixture of clover, Dutch clover, trefoil, and rye-grass. There are, however, many departures from this rotation; peas or beans occasionally taking the place of clover after barley. At other times, on strong loams, when the land is in good condition, barley is sown after stubble turnips, the rotation then is:—

1, Turnips; 2, Barley; 3, Seeds; 4, Wheat, followed by Stubble Turnips; 5, Barley; 6, Seeds; 7, Wheat; or

1, Turnips; 2, Barley; 3, Seeds; 4, Wheat; 5, Tares and afterwards Rape; 6, Wheat.

Tares are sown as soon after harvest as the stubbles can be ploughed; they are consumed by the horses and cattle or folded by sheep. The land is then ploughed and worked with harrows, to get out the couch, after which a second ploughing is generally given, and 1 gallon per acre of rape sown broadcast.

These operations ought to be over in June, and in October the rape is folded with sheep. It is considered excellent feed, and sheep are invariably found to do better on it than on turnips.

Upon the warm loams trifolium is universally grown, and is sown upon the wheat stubbles, which are frequently merely broken up with the cultivator and the rubbish collected and burnt; at other times they are ploughed once and then rolled heavily, in order to obtain a firm bed for the seed. It succeeds best after an early harvest, as the young plant has then time to attain a vigorous growth before winter. Late sown trifolium is frequently lost from the dying off of the young plant during frost. It is, perhaps, quite unnecessary to mention the invaluable nature of trifolium for the purposes of soiling and folding; its only drawback is the difficulty of preserving the plant through the winter. This is an evil, however, which generally arises from late sowing.

A new trade has been opened to this district since the completion of the South-Western Railway, from the convenience thus afforded of sending milk and vegetables to London. Carrots and peas are frequently grown for this purpose, and several dairies of 20 to 30 cows are kept, and the milk sent regularly to town, the price being 1*s.* 4*d.* for 9 quarts, delivered at Waterloo Terminus. This practice would answer well, were it not for the risk which attends the dealing with those parties, whose business it is to receive the milk and hawk it about the streets; and which often renders it a troublesome and sometimes a profitless affair. Some better organization is demanded, by which the metropolis might be provided with good milk from the country, without risk to those who supply it.

The London Clay.—The southern portion of this district consists of a retentive clay on a clay subsoil. It is naturally stubborn to cultivate, but has its productiveness much increased by draining. The fields, which are small, ranging from 6 to 10 acres, have often open ditches around them to drain off the surface water. In consequence of the low and flat character of the land, hundreds of acres are every year inundated by the overflow of the rivers Mole and Wey. Where this is the case, under-draining is of course impracticable, and all other improvements are in that particular neighbourhood very much retarded.

The rent of the heavy land averages about 1*l.* per acre; rates, 5*s.*; rent charge in lieu of tithe 5*s.* per acre.

Fallow for wheat is the foundation of the course of cropping, which is either a 4 or a 5 course, thus:—

1, Fallow; 2, Wheat; 3, Clover; 4, Beans or Oats; or

1, Fallow; 2, Wheat; 3, Clover; 4, Wheat; 5, Beans or Oats.

The fallows are principally long fallows, except that in some cases tares are grown for soiling horses and cattle; swedes and mangold are occasionally grown but not frequently, as the stiff land will not admit of being folded, and the practice of carting roots to the sheep in yards has not as yet been adopted to any extent. Occasionally wheat is omitted after the long fallow, which remains through the winter, and in the spring is sown with barley. The crop thus obtained is generally excellent and of good quality; the land also is improved by its rest from the too frequent growth of wheat, the next crop of which is greatly benefited thereby. When it is intended to treat a portion of the fallow in this way, it is the custom in the autumn to plough the land in 5 bout ridges; this admits of the barley being drilled with the Suffolk drill, without the necessity of treading, as the horses can always be made to walk in the furrows.

Adjoining the Thames on the northern portion of the county, is a fertile, sandy loam, and gravelly soil. Here the fields are 20 to 40 acres in extent; the farms average about 200 acres, at a rental of 30*s.* to 40*s.* per acre; rates are 7*s.* in the pound, and rent charge 5*s.* to 6*s.* per acre. The farms are generally held by lease of 7 to 14 years.

In some cases the 4-course system is adopted, but more generally it is lengthened into a 5-course, thus:—

1, Turnips; 2, Barley; 3, Clover or Seeds; 4, Wheat; 5, Barley.

Occasionally when the land is become what is termed "clover-sick," peas or beans are sown after the first barley crop, and are found to make a good preparation for wheat. As in other districts, where the land is not too heavy, turnips, swedes, and mangold are grown upon the fallow, green crops are also sown for folding or soiling. In the case of trifolium incarnatum, which is grown to a great extent, it is the custom merely to scarify the land, and after burning or carting off the barley-stubble to sow 15 or 20 lbs. of seed per acre. This is done in September, and in the succeeding spring the trifolium is either folded or soiled in time to prepare the land for swedes.

Very few oxen are kept. Southdown sheep are purchased at the fairs, in numbers regulated by the growth of roots, &c. On some of the farms from 100 to 150 cows are kept, and the milk sent to the various stations of the South-Western Railway, and conveyed to the Waterloo terminus for the supply of the London market. The proportion of meadow-land in this district is large—a great breadth having been appropriated for this purpose on the banks of the rivers which were before mentioned, and in consequence of the frequency of floods the land could not be better applied. The water of the Mole is used for irrigation

in the parishes of Cobham and Stoke Dabernon, and with a small outlay of capital might be applied extensively. The superiority of the water of this river, in comparison to that of the Wey, is a circumstance noticed by Stephenson, and by the earliest writers on the subject, and is accounted for by the different earths which they accumulate in their respective courses. The former of these rivers, after traversing the Weald, washes the chalk in its passage from Dorking to Leatherhead, and becomes impregnated with the fertilizing substances which are peculiar to that formation: while the latter flows almost entirely through a sand district, and only touches the chalk at Guildford, where the ridge is narrow; and in consequence the water of the Wey is not only inferior in its fertilizing properties to that of the Mole, but in some instances is positively injurious from the quantity of sand which follows its current.

In consequence of the convenience of carriage great varieties of manures are procured from London and elsewhere; those chiefly used are guano, bone-dust, superphosphate, malt-dust, ashes, salt, and soot—they are principally applied for green crops. Chalk is also extensively used, and is brought from Basingstoke, in Hants, being delivered at the stations of the South-Western Railway for about 4*s.* a ton. It is carted upon the fallows and on the fields in which turnips have been folded, the usual dressing is 10 tons an acre. Threshing machines are more common than in any other part of the county, and are to be found upon almost every farm. Portable machines are hired by those occupiers who do not possess one themselves—they are nearly all worked by horse power. It is the custom to sow much earlier than formerly, the land is kept far cleaner, green crops are more frequently grown, and every crop of corn is horse-hoed. Upon the sands and gravel, too frequent ploughing is injurious, as it exposes the land to the burning influence of the sun; scarifying is therefore substituted, on the sowing of the barley stubble with green crops, and when it is otherwise practicable. The implements, and more especially the plough, are much improved, and on the clay lands three horses at length are used for ploughing, where formerly there were never less than four. Great improvement could be made in the farm buildings, which have been constructed in former years on the detached and inconvenient system, so that the liquid manure finds its way into the ditches instead of into a tank. It is by no means a matter of regret that the removal of many of the buildings must before very long become necessary, when it is to be hoped they will be erected in central positions, and upon an improved plan.

A characteristic of this part of Surrey, although it can hardly be called an agricultural topic, is the number of market gardens.

Forty years ago, many acres were appropriated for this purpose, which the extended suburbs of the metropolis have since covered with streets and buildings; and the market gardens have been pushed farther into the country. A great portion of the northern part of the county is now occupied by them; as at Battersea, Wandsworth, Mortlake, Streatham, &c. Extensive nurseries have been established in different parts of Surrey, upon the sand and peat soils which are adapted for them; and several noted ones are situated at Woking, Knap Hill, and Bagshot.

The Chalk District consists of the elevated ridge which has already been described as stretching throughout the entire breadth of the county. The Downs, which constitute a considerable portion of this district, are hereafter noticed in connection with the greensand, as forming an important portion of the farms lying on that formation. In a few instances, the natural herbage which clothes the sides of the chalk ridge, producing alike an imposing prospect and a useful pasturage, has been broken up and brought under tillage; but the change seldom results in improvement, the unlevel position of the ground opposing a natural barrier to its cultivation, while the scantiness of the produce forms a very insufficient return for the necessary outlay. Under these circumstances, the Downs will remain one of the most prominent features of a beautiful locality, and it is to be hoped that in no case the desire for "improvement" will be carried so far as to destroy the beauties of the country, unless a decided advantage to agriculture can be secured as the result.

The other soils of this district, besides the rubbly land and the pure chalk, are the sands and the flinty clays of the *diluvium* which overlies the chalk, as already indicated. In the neighbourhood of Banstead and Walton-on-the-Hill, where this deposit is extensively developed, there is a considerable area of barren heath. The heavy "black land" which occurs in the same locality, and the loam produced by the intermixture of these various soils, complete the list.

The size of the farms varies from 200 to 600 acres, the average being about 300; the fields are generally large and open, far more so than in any other district, so that little improvement in this respect can be effected. The rate of rental is about 1*l.* per acre, rates 4*s.*; and in the eastern portion of the district (where the nearness of the London market raises the value of the produce) the rent-charge amounts frequently to 7*s.* per acre.

The course of cropping does not differ from that which is most common throughout the county, being the 4 or 5 course, viz.:—

1, Turnips; 2, Barley; 3, Seeds; 4, Wheat; or,

1, Turnips; 2, Barley; 3, Seeds; 4, Wheat; 5, Oats.

In the eastern part of the district, and within convenient dis-

tance of the railroads, very little stock is kept besides sheep, which is to be accounted for by the facility of procuring dung from London. It is the custom to manure for wheat and turnips alone; artificial manures are but little used, with the exception of superphosphate, which is in general use for turnips, 3 cwts. per acre being a customary dressing. Sainfoin thrives indiscriminately upon all soils, however poor, provided the subsoil be of chalk; its roots will even penetrate to the depth of many feet, in search of the calcareous soil which affords them food. It is the custom to sow sainfoin with barley, in the same way as clover. It remains about 10 or 12 years; after which the land is broken up (sometimes pared and burned), and sown with oats, &c. About a tenth part of the farm is devoted to this crop; and in the eastern part of the county, or wherever there is the convenience of railway carriage, the hay is taken to the London market, and is sold for about as much per ton as clover. Two-thirds of the crop are disposed of in this way, the remainder being consumed on the farm.

But few sheep are bred in the neighbourhood: around Banstead there may perhaps be as many as 1200 breeding ewes, a number hardly worthy of mention; and the Southdown is almost universal here, as well as in other parts of the county.

With the exception of the growth of sainfoin, there is nothing in the farming to separate this from other districts. The course of cropping which has been given, although it is that which is most commonly pursued, does not pretend to include the whole practice; since where chalk, sand, and clay are all found intermixed, the system becomes as various as the soils.

The Hop District of Farnham.—The quantity of hops grown in this locality is small, compared to that of the larger districts of Kent and Sussex: it is nevertheless presumed that the following details will not be out of place, the Farnham hops having long maintained a name in the market which authorizes the noting here some of those circumstances which conduce to their superiority.

For much information on this subject the writer is indebted to Mr. Paine, a gentleman well known as an eminent hop-grower, and a most enterprising farmer.

The uncommon fertility of this locality is to be attributed to the proximity of the various strata, and to the mineral fertilizers which they contain. The London clay, the Bagshot sand, and the several members of the cretaceous formation; the chalk, the greensands, and the galt, successively appear at the surface, within a very small area. The presence of a fertilizing marl has been long known here, and the benefit of its application to the land has been practically recognised for many years, as is evident

by the extent to which the marl-pits have been worked; but we are indebted to modern science for an accurate investigation into the nature and composition of the substances referred to, and for the consequent improvements in the method of manufacturing and applying them to the land.*

The principal deposits of fossiliferous substances are found at the junction of the chalk with the upper greensand which lies immediately below; and also below the galt, and between it and the lower greensand: they are also discovered in the galt itself, but not in sufficient quantities to be made available. The writer is not aware that any extensive discoveries of similar phosphoric substances have been made in any other part of the county, there is no doubt, however, that they are to be found more or less throughout the entire length of the north downs, in the position already indicated; and where they occur in quantities sufficient they must eventually become of considerable importance as a native manure. The deposits in connection with the greensand are frequently several feet in thickness; and when this is the case they become valuable for the purpose which is about to be described, viz., as a cheap substitute for bones in the manufacture of superphosphate of lime.

According to the statement of Professor Way, in the 12th volume of the Journal, in an article "On Superphosphate of Lime: its Composition, and the Manner of Making and Using it," we find that "The fossils of the upper greensand contain from 55 to 60 per cent. of phosphate, and 8 to 10 of carbonate of lime; and those of the lower green sand from 38 to 40 per cent. of phosphate, with little or no carbonate." As the whole process of digging and grinding has been described in the article by Messrs. Paine and Way, it will be sufficient to notice here, that as the fossils are dug they are sifted in the same manner as common gravel (the siftings are carted on the land, and in some instances pay the whole labour of digging), they are then reduced to powder in the mill which is "attached to the machinery of a small threshing-machine; it consists of two pairs of cylinders, the upper one being fluted transversely. Scrapers, like those used in a common bone-mill, are indispensable. Two horses will grind from 2 to 5 tons a-day, according to the hardness of the substance." To manufacture superphosphate, of which large quantities are made on the farm of Mr. Paine, to every cwt. of powdered phosphate of lime are added 30 lbs. of sulphuric acid, and 12 lbs. (3 quarts) of water; the mixture is then thrown into

* For a detailed account of these most interesting investigations the reader is referred to an article in the ninth volume of this Journal, 'On the Phosphoric Strata of the Chalk Formation,' by Messrs. Paine and Way, and to a more recent article in the first part of this volume.

a heap, and allowed to remain until a thorough incorporation takes place between the particles of the several ingredients.

Having thus briefly described the process of making superphosphate of lime pursued by Mr. Paine, the writer will proceed to notice its application and effect as a manure; and in doing so it may not be uninteresting to introduce some particulars of that gentleman's farming, which his kindness enables the writer to detail.

From the scattered position of the fields a central homestead would employ too much cartage, consequently no very extensive operations are carried on at one spot. Threshing has hitherto been done by horse-power, but it is the intention of the proprietor to employ a portable steam-engine for this purpose, and for grinding the fossils. The farm buildings, which are not of modern construction, are shooted to carry off the drip; and the yards are provided with a tank at the lower end, into which the soakage drains, and which can be emptied at pleasure, by means of a portable pump connected with a gutta-percha tube 250 yards in length. The liquid manure is thus available for watering the adjacent fields, and has been found to produce a considerable effect upon hops, and, in fact, upon every crop to which it has been applied: to work the apparatus two men are required at the pump, and one to direct the jet; except when the spot to be watered is situated below the level of the tank, in which case the tube of course acts as a syphon, and when once set to work needs but one man to direct it. A small tank is attached to each stable, which is supplied with ashes; as the ashes become saturated with urine they are carted to a spot under cover, to be mixed with the superphosphate and drilled with turnips, as will be noticed hereafter. It may be mentioned here, that the dung is carted from the yards by means of a portable railroad of 600 yards in length, by which it is considered that a saving of labour is effected, while the treading of the land, so injurious in wet weather, is entirely avoided. It is the practice on this farm to feed sheep in yards, where they receive cake and cut turnips; low sheds are erected on the side of the yards sufficient to afford shelter to the sheep. The trimmings of the turnips are given to store pigs; oxen which are tied up in stalls are fattened in the usual manner, and the manure thus made is carted to the field and mixed. The yards are supplied with tanks, as already described. It is found that the sheep in yards thrive better than those folded in the fields.

As may be supposed, upon land which possesses such a rich source of fertility from the peculiar nature of its composition, no particular course of cropping is necessary. It is confidently asserted that in those fields where the richest supply of mineral

manure occurs, the staple of the land is sufficiently good to allow, with the addition of proper manures, of successive crops of corn being grown, with occasionally a crop of roots to be drawn off, for an indefinite period.

The galt on this farm is of two kinds, one well known as a stiff intractable clay; the other having been denuded and subsequently covered with a later deposit of gravelly drift, is less difficult to work: both are comparatively worthless until drained. The true galt is drained by tiles put in 4 feet deep by 12 to 18 feet apart; the gravel drift is laid dry by drains 4 or 5 feet deep by 11 yards apart. After draining the land is trenched with spuds for about 4*l.* 12*s.* an acre, at a depth of 18 or 20 inches; this operation can seldom be performed by the subsoil plough, in consequence of the treading; when done by hand labour the "pan" is effectually broken, allowing the water to penetrate freely to the drains; and although the cost is considerable, one fleet ploughing in the spring leaves the land in a state fit for the reception of the seed. Mangel or swedes is the first crop; they are drilled with a mixture of 4 cwt. of superphosphate and 15 bushels of the ashes from the tanks; from 2 to 3 cwt. of guano are sown broadcast. This is a dressing which, it must be confessed, is sufficiently liberal, but which is amply warranted by the crops produced. The land which is thus described is converted from a comparatively worthless to a most productive state; and wet pastures, which (in this highly-rented locality) let for 10*s.* an acre before draining, have been raised to a rental of 10*l.* per acre for hop land.

Another soil on this farm which deserves mention is on the upper greensand; the surface soil is shallow, it, nevertheless, produces good crops both of hops and corn; a circumstance which is owing to the mineral nature of its subsoil; so that even when, for the purposes of experiment, the surface soil has been removed the productiveness of the crops has not been materially diminished.

The poor soils of this farm consist of those lying on the lower greensand and the upper chalk: the high system of farming pursued, however, and the rich supply of manure found on the farm itself have enabled the owner, even on this soil, to produce excellent crops.

It is the custom at long intervals to subsoil the whole of the farm, and to apply *occasionally* 120 bushels of lime to the acre, which, *in this neighbourhood*, is found to be a complete preventive of the club in turnips; the same may be said of marl.

For turnips, swedes, mangolds, and cabbage, a mixture of 4 cwt. of superphosphate with 15 bushels of ashes from the tanks is drilled with the seed, while from 2 to 3 cwt. of guano are sown

broadcast. One half of the crop is carted to the sheep yards, and the other half is folded with sheep in the fields.

Superphosphate is considered useless for wheat, but will answer for barley and oats: corn crops and roots are dressed entirely with artificials, the phosphate and ammoniate, in its most convenient form, being found sufficient for them; while the hops, which require carbonaceous manures, receive the whole of the farm-yard dung.

It will be unnecessary to enter here into the details of the management of hops, as that subject has been ably treated of in the pages of this journal by Mr. Rutley in vol. ix. It may be mentioned, that the chief supply of poles is from the plantations in the neighbourhood of Hindhead. The application of liquid manure to the hills in summer has been found to produce a good effect. It need scarcely be said that thorough drainage has been effected in all the hop plantations which needed it. The rents vary from 3*l.* to 20*l.* per acre, while 600*l.* per acre has in some instances been paid for land. The extent of hops cultivated in this district amounts to about 2000 acres, 500 of which are grown in the adjacent county of Hampshire. The hop plantations on the farm that has been just noticed contain about 200 acres.

The Greensand District.—The extent of land lying between the North Downs and the Weald consists of farms possessing every variety of soil, from the stiff clay of the galt and the rich loams of Godalming to the sand of the heaths.

The size of the farms and of the fields also varies greatly; in many instances on the borders of the weald, for example, they are poor and small, while at the foot of the downs they become larger and more valuable. A serious evil in this district is the quantity of game: it has before been noticed that good loams, capable of growing from 8 to 10 sacks of wheat per acre, with roots, &c., in proportion, are frequently surrounded by land growing nothing but gorse, underwood, or fir: upon these warm sands rabbits, the most destructive of vermin, increase to an astonishing extent: and even where the right of killing them is possessed by the tenant, the quantity of waste land where they are bred is so great that considerable injury is sometimes done by them. Fortunately, the right of killing rabbits is much more common than of old, and ought to be *universal;* since the depredations committed by them upon the crops at every period of their growth are even greater than the injury arising from hedgerows and timber.

The size of farms varies from 100 to 500 acres; generally they are small, and perhaps 250 acres is quite an average. They are occasionally held by lease, but yearly holdings are most

common. The rate of rental varies, from that of the heath land worth but a few shillings an acre, to that of the best loams, worth 30*s.* to 35*s.*; the average of rents is low, a circumstance which is easily accounted for by the quantity of waste land: many of the farms may be had at 15*s.* per acre: rates are about 4*s.* to 6*s.* in the pound; rent-charge in lieu of tithes, 4*s.* to 6*s.* per acre; wages, 9*s.* to 10*s.* a week. Most of the corn is threshed by flail.

Sheep are kept in great numbers; adjoining the downs it is the custom to buy in lambs in the autumn, give them cut turnips and swedes through the winter, and either sell them off in the spring, if they are found in good condition, and buy in a fresh stock, or summer the same on the downs. It is the custom through the summer to keep them on the downs in the day-time, and to give them a fold in the "seeds" at night. On some of the early farms they are frequently put on turnips by the first fortnight in September, and are fattened at two years old, and generally without corn, being selected through the winter and spring for Smithfield and the country markets. Ewes are sometimes kept to sell off fat after lambing; the lambs are fattened in the usual manner. The Southdown sheep is almost universal. Pigs are fattened on some of the farms in considerable numbers. Oxen are either a mixed variety bred on the farm, or more generally Devons, Herefords, or Welsh bought at the fairs. They are often fattened while running loose in the small yards belonging to the detached homesteads, which are but too common; the more usual custom is to tie them up in sheds open to the yard, but the most approved method, and of which there are a few instances, is to fat them loose in boxes.

The general rotation of cropping is the four-course, viz., 1, turnips; 2, barley; 3, seeds; 4, wheat. Peas are often sown as a fifth crop; and a part of the fallow is generally devoted to the growth of tares, rye, and trifolium; but this is not so much done as might be supposed from the early nature of the soil.

It is the custom to plough up the wheat stubbles as soon after harvest as possible; and when trifolium is sown it cannot be done too early.

On the heavy land of the galt, lying immediately under the chalk, the above rotation cannot be observed; mangolds are frequently grown instead of turnips, then wheat, and afterwards beans. Carrots and cabbage are occasionally grown, but the former not to the extent which the nature of the light land seems to render advisable.

Turnips are invariably grown on the flat, the ridge system not answering on these dry soils. The most common sorts are the Pomeranian and green-round; and of swedes, Skirving's purple-

top. They are sometimes sown as the land is ploughed, by means of a hand-drill which passes up every other furrow, but more generally by some of the larger drills. Drills of very large construction are objected to on account of the uneven character of the land. Barley is generally the chevalier; the seeds which are sown with the barley are a mixture of clover, trefoil, white clover, and ryegrass, or, as it is called by the farmers of this district, "bents." Clover upon these soils can seldom be depended on alone, although it makes by far the best ley; and the rye-grass, though objectionable as a cereal, can seldom be omitted without very much diminishing the bulk of hay. Wheat is grown of the best quality; and Guildford market boasts of samples equal to any in England; the most approved sort is the Chiddam; Talavera is preferred for late sowing; another white wheat, called Red-straw, is considered to be more productive, but suffers more in a wet harvest, and does not command so good a price. The quantity usually drilled is $1\frac{1}{2}$ to 2 bushels per acre; old seed is sown dry, but new wheat is prepared as a preventive of smut by being limed: 1 gal. of lime slacked in boiling water is poured over six bushels of seed. The leys are generally *pressed* to render them firmer; the *presser* consists of a pair of heavy iron wheels 27 inches in diameter, placed at the same width as the furrows; one or two horses draw the presser, one of which follows every pair of ploughs. The field, when pressed, is left in deep seams of 9 inches in width, and when the wheat is sown broadcast, which in a busy time is sometimes done, the corn, from falling into the seams, comes up with great regularity, and can scarcely be distinguished from that which is drilled. Guano and nitrate of soda are extensively used, and upon these soils are carefully applied to assist the poor spots.

Waggons are universally used to harvest the corn; and where the land is of such an uneven character, it is very doubtful if one-horse carts could be employed to advantage. Horse-rakes are occasionally employed, and offer such an obvious advantage, that they cannot fail to come into general use.

The Weald of Surrey borders on that of Sussex, and resembles it in its soil and mode of culture. There is little that is attractive in the farming, which is obviously confined in its character. The subsoil is the ragstone, or more frequently a pale clay, and can only be improved by long and constant tillage, so that there is a natural dread of ploughing deeper than the surface soil: this is sometimes no more than 4 inches deep, at other times upwards of 12.

The farms are smaller than in other parts of the county: few are more than 250 acres, the average being about 200 acres; the fields also are small, but are constantly being enlarged.

There are but few leases, most of the occupiers being tenants-at-will. The rate of rental is about 10*s.* per acre ; rates, 2*s.* in the pound; rent-charge in lieu of tithe, 4*s.* per acre ; for woodlands the rent is 5*s.* to 10*s.* per acre.

A great increase in the quantity of stock kept in the Weald is a proof of the improvement in the farming, and is a guarantee of an increase of productiveness in the future. The means by which this change has been brought about consist in the introduction of mangold, the cultivation of cabbage for horned stock, and the extended growth of turnips and swedes for sheep. The land will not always admit of being folded; but it is now customary to cart the roots to the sheep in yards, a method of feeding which is becoming general, and cannot fail to be of great advantage. Sheep are of the Southdown breed, and oxen either Sussex, Hereford, Devon, Welsh, or Short-horn.

The implements are necessarily heavier than in other districts, but those of a lighter construction than were formerly used are found to answer; the Guildford swing-plough is occasionally used, but more generally one of heavier make, with a wooden beam and cast-iron fittings. The Suffolk drill is preferred.

The system of cropping is greatly improved by the more general growth of green crops and roots. Fallow for wheat is still the foundation of the system. The following is the usual course: —1 fallow, 2 wheat, 3 seeds, 4 oats; after which, if the land is sufficiently clean, tares are sown, and fed off before fallowing. When the land is tolerably friable turnips and swedes are sown in the place of tares, and, if the season is sufficiently dry, are folded on the land, otherwise they are carted to the yards. The sorts are, of turnips the green-round, and of swedes, Skirving's and the green-top; they are drilled by the end of May, or as soon after as possible. Garrett's horse-hoe is sometimes used, but is not generally considered available here on account of the hardness of the ground. Red wheat is more common than white, and the sorts are golden-drop, castle-glory, fluff, and trump; the white and black one-sided Tartarian oat is sown. Barley is increasing in growth in localities where it was not formerly thought of.

The greatest improvement which has taken place in the culture of this heavy land district is the breaking up of the stubble in autumn, or as soon after as the weather will permit, exposing it to the influence of frost, then ploughing it twice or thrice, and taking a crop of roots or tares instead of a clear fallow for wheat.

It may be mentioned that bad roads are, comparatively speaking, unknown.

Guano, nitrate of soda, and superphosphate, are in general use.

The several items of draining, inclosures, buildings, and timber-trees will be noticed under their respective heads.

The Heaths and Waste Lands, including parks, commons, &c., amounted, according to Stephenson, to one-sixth of the area of the county. This proportion is now greatly lessened by the extensive inclosures which have taken place, but a large portion of the western area of Surrey must ever remain irreclaimable. The heaths of Frensham, Whitley, and Thursley on the south, and of Frimley, Bagshot, and Woking on the north, consist of a sterile and unimprovable sand, while a great part of the intermediate country is of a similarly poor nature; only a few patches of good loam are to be found, and the district must always remain comparatively worthless in an agricultural point of view, and its products ever be confined to the growth of heath, gorse, fern, and a few plantations of larch and Scotch fir.

On Bradley common an extent of more than 100 acres is being reclaimed at an expense of 7*l.* or 8*l.* an acre; but it appears doubtful if the larch and Scotch fir which have been planted will thrive.

The process of breaking up the ground consists in paring, burning the heath, and trenching, by spade and pick, to the depth of 20 inches, or more, according to circumstances. This depth is generally sufficient to break through the "iron crust" which is invariably found below the surface of the sand, and which, being impervious to water, is the cause of the heaths being frequently wet and boggy.

In the neighbourhood of Worplesdon, Pirbright, and Ash, considerable pits of peat occur, but have not at present been applied to agricultural purposes.

The Use of Lime as a Manure; to what Soils (if any) it is confined; and whether its Employment is at all Diminished by High Farming.—Lime is used more or less throughout the whole county, but the introduction of artificial manures has greatly lessened its importance. It is now chiefly valued as a preventive of club in turnips, for which purpose its good effects are very remarkable, and are frequently to be seen after the lapse of many years. There are instances on the loams of the greensand of excellent crops of turnips being grown on land which had been limed twelve years before, while the club has been destructive on similar soils, and even in the same field where the lime has been omitted.

The use of lime is principally confined to the various soils which, lying within convenient distance of the chalk, are found to be wanting in calcareous matter. When much cartage is employed, guano is preferred as a cheaper and more efficacious manure; and almost the only instance of lime being extensively

used—not simply as a preventive—is when the kiln is situated on the farm, and the materials for burning are near at hand, and not otherwise valuable.

The beneficial effect of quick-lime proceeds from its property of decomposing some of those organic and inorganic substances which previously existed in the soil in an insoluble form, and rendering them soluble, thus converting the dormant elements of fertility into a state fit for appropriation by the growing crop. These fertilizing agents are now supplied in a cheaper and more universal form by the introduction of the various artificial manures; and it is to this circumstance that the great diminution in the use of lime throughout the country is to be attributed.

The Interference of Small Inclosures with Improved Husbandry.—This is best appreciated by the farmer who has experienced its numerous evils—evils which are too well known to need repetition, and upon which nothing new can be said here, though it is a subject upon which it is feared the experience of the Surrey farmer has been both wide and of long duration.

Setting aside the harbour for slugs, sparrows, rabbits, and other vermin, the injury done by shading and absorbing the nourishment of the crops, and the encouragement of weeds and couch upon the headlands, all unnecessary hedges and timber must invariably occupy ground which ought to be more profitably applied, and which might be tilled at a cost not greater than that required to keep the hedge-rows in order. That crisis, however, which has roused the energies of all connected with agriculture, and made them strive "to make two blades of grass grow where but one grew before," has struck at the root of this great evil, and all but the tourist may be delighted by the sight of hedges and timber falling in all directions. The change in this respect within the last few years has been immense, and still proceeds.

Perhaps it may be said that throughout the chalk range the fields are of good size; and around Guildford, where for many years an excellent example of good farming has been afforded, but little improvement in this respect could be effected. On the loams of Godalming—and in fact wherever the best land is found—the fields *are*, or are fast becoming, of good size. Improvements of all kinds are most tardy in reaching the poor soils, and those which afford the least return for their introduction. On some of the clay of the London basin, where draining is still required, the fields are much encumbered by timber and hedge-rows; and it is probable that the two improvements of draining and grubbing will take place together. The smallest inclosures are to be found in the Weald, and this is the only case where the advantages of grubbing are less obvious; but, upon some of the

most unprofitable clays, the expense of tillage and the small produce yielded by the cultivation of the land render the propriety of displacing the "weed" of that district very questionable. The oak, therefore, under such circumstances is likely to flourish undisturbed, to the detriment of all other crops.

The effect of Soil on the Growth of Timber Trees.—Surrey is a richly-wooded county, and, as may be supposed from the nature of its soils, possesses every variety of timber trees. Perhaps the most luxuriant trees are to be found on the deep clay of the galt, where the oak, the elm, and the ash are most common. On the sands of the western part of the county the oak and elm are scarcely to be found, and are miserably stunted in their growth, the soil being too poor in some cases to produce even the fir itself. The poor brows, which are so common throughout the greensand to the south of the downs, are generally covered with gorse or fir plantations, or are devoted to the growth of underwood for the purpose of making hurdles and hoops; while the hedge-rows on the loams produce freely oak, elm, and ash.

On the thin soil of the chalk-ridge beech and yew are plentiful; some noble specimens of the former are found on the loams of the Wotton Woods, which were planted by the celebrated Evelyn. The chestnut is found in almost every locality, but the most noble trees grow on dry loamy soil, as at Albury Park.

On the London clay elm grows most freely. The Weald, which at some distant period formed one entire forest, and which has gradually been reclaimed and made arable to supply the wants of its inhabitants, has been long noted for producing the oak in its greatest perfection. And even now there is no crop which, in certain situations, is more profitable: upon the most difficult and profitless clays, where the scantiness of the produce is no compensation for the labour and expense of cultivation, the oak remains as the staple production of the soil, and here it attains perfection both in the nobleness of its size and the durability of its timber. The slowness of its growth seems to be one great cause for this latter excellence, since, upon richer and warmer soils, where the trees grow much more rapidly, they are invariably softer and less durable in their wood. Every part of the tree seems equally favoured in this locality, and *bark* from the Weald is that which is most highly prized by the tanner.

The above brief sketch will form an indication of the kinds of trees which are to be found in various situations—a knowledge which, to an attentive observer, is often a correct indication of the soil.

The suitableness or otherwise of the Farm-Buildings to improved

Husbandry.—The buildings throughout Surrey are very inferior: although many improved homesteads have been erected, there is still no single locality which does not abound in old-fashioned, badly-arranged, and patched farm-buildings. The farmers are growing more and more aware of the nature and importance of liquid manure, and are beginning to make every effort for its preservation which their means will allow; it is, nevertheless, frequently to be seen discolouring the horse-pond or flowing over the road, instead of conducing to the abundance of our crops. In travelling through the county, a stranger would be struck by the number of thatched buildings and detached outhouses which too often form the apology for farm-buildings; and in the Weald especially they are frequently placed in a deep hollow, apparently with a view to shelter them from observation! The more immediate effect consists in the abundant supply of water which is conducted through the yard; and, as water is no longer the principal item in the manufacture of farm-yard manure, a general remodelling of the buildings is greatly required. It would not be doing justice, however, to the enterprise and capital which are now being directed to the improvement of agriculture in Surrey, as well as elsewhere, if the writer omitted to mention the change which is taking place with respect to farm-buildings, as well as every other branch of the art. The first step which is taken for improvement is to prevent the too great access of water to the yard by shooting the tiles or thatch; and where the desire for improvement exists, the buildings are brought more compactly together, and are occasionally constructed upon such a uniform plan as admits of the application of machinery for threshing, cutting chaff and roots, and grinding corn, &c. Boxes for the fattening of cattle loose have in a few instances been erected, and are highly approved.

It will not be necessary to particularize upon a subject which presents nothing new for the notice of the Society; it may therefore be sufficient to observe, that while there is no single locality which does not admit of great improvement in its farm-buildings, there is not one which does not present some gratifying exceptions to the general neglect.

The extent of Under-Draining effected in the County.—The greatest proportion of draining has been effected in the Weald, and upon the London clay; in many of the other districts the nature of the surface causes the land to suffer more from the lack than from the superabundance of moisture. Nevertheless, the character of the substratum frequently renders some of the light land exceedingly wet and *springy;* this is the case at Chertsey and the neighbourhood, where the soil is a strong and stiff loam with a substratum of clay. Here a great portion of draining has

been already effected, much is being done at the present time, and probably in a few years all will have been accomplished. An instance of the necessity for light-land draining is upon the upper greensand throughout the whole length of the downs. Here the clay of the adjacent stratum of galt preventing the escape of the water which has made its way though the chalk above, it frequently rises to the surface, causing springy places where they might be least expected, were it not that the clay prevents that natural drainage which would otherwise take place. Considerable improvement might be effected by the draining of these spots, for although they do not occur to great extent on any one farm, still they are a constant annoyance where they do exist: they are, nevertheless, frequently allowed to remain, being looked upon as a necessary evil; and the constant and expensive routine of clod breaking is submitted to as the seasons come round, when one or two drains, properly laid down, would cure the nuisance and render the springy places as dry as the rest of the field. Draining, however, as it is little required, so it is little appreciated, in the light land district; and in those few instances where it would be beneficial, it is frequently neglected. Consequently, draining is often left undone upon the galt clay, which, as it forms but a narrow strip at the foot of the chalk-ridge, invariably occurs on farms the principal portion of which consist of light land. Of the Weald it may be said, that all that part which has not been drained stands in need of it: much still has to be done, for it is estimated that *two-thirds of the Weald yet remain undrained.* The work, however, progresses, and a few more years must render the proportions much more satisfactory. The most approved method now is by the circular pipes, which are put in much deeper than formerly, the usual depth being from 30 to 48 inches. Much draining has also been done upon the London clay, and in several instances the Government loan has been made available for that purpose. The benefit in this district (where the clay is deeper and more productive than in the Weald) is recognised by all; and although a considerable breadth remains unfinished, it is in rapid progress. A large portion of the land on the banks of the Wey and Mole is exceedingly flat and low, while the number of flour and other mills frequently causes the water to head back, to the great detriment of the land; hundreds of acres are every year flooded from this cause, and under-drainage is of course out of the question. Pipe-draining is common in the district; but it has been the practice to put in heather or bushes at a depth of 30 to 36 inches, and, from the cohesive nature of the clay, the drains have been found to remain for 20 or 30 years, even after the decay of the material which was used.

The Improvements made since the Report of W. Stephenson in 1813, *and to what extent still required.*—They may be divided into two kinds; first, *general* improvements, or those which have been effected in the agricultural world at large; and, secondly, *particular* improvements, by which is meant, those which more especially apply to this county. It is not the province of the writer to speak here of the causes of these improvements; it may be safely assumed that the same circumstances which gradually advance all other branches of industry will apply to this, and that as the increase of population and of wealth have created a demand, the energies of the producer have been excited to increase the supply in proportion. Forty years ago, 17,139 sheep and 2649 beasts were the average weekly supply of Smithfield Market; at the present time, 30,000 sheep and 5000 beasts are no unusual number, while the facilities of conveyance have enlarged the "dead market" in still greater proportion. It is true that the population of London has greatly increased, but this increase is more than counterbalanced, as far as the supply of food is concerned, by the establishment of numerous country markets, to which the convenience of railroads has given the London butchers access, and which now take a prominent part in the supply of the metropolis, and have destroyed the monopoly formerly possessed by the central market. These circumstances render it difficult to estimate the exact increase in the supply of live stock, but that it has been very great is sufficiently evident. This broad fact (notwithstanding that the teeming population of this country has no longer to depend upon native produce for subsistence) has had its influence in every district and upon every farm; so that, in the words of a valued correspondent, in a locality where "a few Welsh cows were formerly kept, with straw for their principal food, there is now an eagerness for making meat in the yards as well as in the fields. The increase in the quantity of sheep is great, and on my own farm I make off more than 50 per cent. more stock than 40 years ago."

Those general advantages which have arisen from the introduction of artificial manures, the increased growth of turnips, and the saving of labour effected by the improvement of machines and implements, are too well known to need description: it may be mentioned that the practice observed by Stephenson—who "saw, between Bagshot and Chobham, 5 strong horses in a swing-plough give a light furrow to a sandy loam, on which the manure was spread for wheat"—is now entirely exploded, and that under such circumstances 2 horses in one of the Guildford ploughs are all that would be allowed. The same writer also tells us that "he met with the drill in a few parts of the county;

they are commonly made to sow 2 drills at once, at 9 inches distance," and "the drilled crops in general are either hand-hoed or not hoed at all; horse-hoes are not common. There are perhaps not 20 acres of drilled turnips in the county." Our practices in these respects are now the same as in other counties.

With respect to leases little change has taken place; indeed, a few years ago there was a great disinclination among farmers to take farms upon lease, with the low price of corn hanging over them: there has been no such diminution of rental, however, as was expected, far better means having been resorted to for the letting of land in the general improvement of the holdings; and much greater confidence and activity in the taking of farms now prevails. In many cases the leases are made terminable by either landlord or tenant at 2, or even 1 year's notice, while yearly holdings are by far the most common. However creditable the confidence thus displayed may be to the proprietors of land, it is evident that where improvements can be effected, the tenant who is willing to undertake them will require a legal security for the capital he invests. It is the custom in the South of England to commence a lease or agreement at Michaelmas. Many of the farms are burdened with a very costly valuation, and as this is more especially the case in this county, some account will be given of what are called "Surrey valuations." Under the most extreme of these arrangements the out-going tenant demands of his successor a sum frequently amounting to 3*l.* 10*s.*, or even 4*l.* an acre, which sum remains dead, so to speak, upon the soil, and is redeemed by a similar exaction at the expiration of the tenancy. There are various modifications of this system, and the nature of the valuation differs upon almost every farm; in many cases an out-going tenant is entitled to the cost of "making the fallows;" of a fourth (under the 4-course system) of his farm, during the last summer of his term; to the amount of rent and taxes on the same, the expense of carting the dung, and the labour thereon; to the value of the dung made from the produce of the 2 last years of the tenancy; to the "value of the leys," the "half-dressings," and the "half-fallows." By "making the fallows," is meant the whole process of ploughing and cleaning them, and afterwards of sowing the root crop, operations which are performed under the superintendence of the landlord or in-coming tenant. The "value of the ley," "half-dressings," and "half-fallows," are terms used by valuers to express the interest which is possessed by the outgoing tenant in the ley-ground which he leaves upon his farm at Michaelmas—in the land from which one crop only has been taken since it was last dressed with farm-yard dung; and in the land from which but one crop has been taken since it was last fallowed. For instance,

upon all the wheat stubbles "half-dressing" is demanded, a wheat-crop only having followed the dunging of the ley; upon the barley stubbles, "half-fallow" and "half-dressing" also is demanded, the barley crop being the only one which has followed the fallowing of the land and the dunging for turnips. The amount of these respective charges varies according to circumstances, and is determined by valuers who are employed for that purpose. The manure which arises from the produce of the last year but one is either measured in the heap, or when it has been spread upon the land for turnips, is valued by the load. The out-going tenant occasionally disposes of his last year's crop to his successor according to a mutual agreement, otherwise he keeps possession of the barns and yards for the purpose of thrashing and foddering; and at Lady-day, or by the 1st of May, a valuation takes place of the manure thus produced. It ought to be mentioned, that the hay and straw is disposed of to the new tenant at a market, a fodder, or a fodder and dung price; the fodder price is its value for consumption upon the farm, and is always considerably less than the actual market value; the fodder and dung price, is its value not simply for the purpose of consumption but with a view to the quantity of dung which it will produce. When the hay and straw are taken at this latter price, the valuation of dung at Lady-day is of course omitted, an estimation of its value having been already agreed upon.

A moderate valuation is by far the most desirable, and the extreme ones must necessarily be an injurious burden upon the land. There have been already several instances of the latter being redeemed by landlords, and it is to be hoped that many others will follow. The effect of an extravagant valuation is obviously to lower the rent of the occupation upon which it presses, and to restrict the number of applicants when a vacancy occurs, since none but a man of capital will submit to an outlay which affords him such a distant prospect of return. The upholders of the system contend that it gives security to landlords and stimulates the tenant to raise the utmost possible produce at the close of his term that he may ensure a good valuation. On the other hand, it is maintained that landlords have at all times a sufficient security, while the tenant's own interest, without any further inducement, must always lead him to use his best endeavours in the cultivation of his farm.

Since the time of Stephenson, and more especially during the last few years, there have been many improvements in the uniting of small holdings and the enlarging of fields, but much remains to be done: the union of small farms has frequently left the homesteads detached, inconvenient and too numerous. The management and care of stock and implements, the improved method of making dung, and the greater convenience for applying

machinery, are all advantages arising from the possessing of a central homestead which are now so generally appreciated, that it is hoped the evil mentioned above will gradually disappear as the opportunity for change occurs. The fact that wet and exposure are injurious to manure is now so generally recognized even by those who never heard of ammonia and volatile salts, that much greater care is taken in the making of farm-yard dung; and although the construction of yards is still very imperfect, we have ceased to hear of cases in which, as the author has been credibly informed, it was the custom on a rainy day to tie 4 horses together and run them over the yards, wet and well treading being all that was considered necessary to make good dung.

By comparing Stephenson's Report of the agriculture of Surrey 40 years ago with the present state of farming, it appears that (making allowance for the improvements in implements) all the manual operations in husbandry were performed nearly as well by our forefathers as at the present day; that all the routines of tillage were well understood, and that long experience had suggested rotations and systems which time has not materially improved. This observation, however, will only apply to the most enlightened and intelligent of that day, and it is probable that there existed many instances of ignorance and neglect, which in the present day would not be permitted by the times we live in. Not to mention then those changes which have taken place in every branch of farming, and which are of too general and obvious a character to need description; the principal improvement after them consists in the better cultivation of the small holdings. So that the systems which were formerly practised by the best farmers only are now more widely appreciated; and the spread of intelligence among the generality of the farming classes is the greatest improvement which can be recorded here. Both the holdings and the inclosures have been enlarged, the buildings have been considerably improved, the farming is generally cleaner, and the spudding of couch in the autumn is more common; and in the Weald a much greater breadth of turnips is grown, while draining has introduced the growth of barley upon some of the drier land to considerable advantage, and the roads have been made hard and sound. To this list of local improvements may be added the inclosure of some of those common fields, as at Ashtead and Epsom, which Stephenson mentions as being in a neglected and unproductive state. Several of the proprietors have already availed themselves of the Act which was passed a few years since to facilitate these inclosures; and it is to be hoped that what still remains unfinished will be speedily accomplished.

A subject which is worthy of more attention by farmers who are surrounded by such a great proportion of waste land is the

use of gorse. At present it is in no instance extensively used by any of the practical farmers; and yet supposing it to answer in any case, it might be advantageously grown upon many of the poor sands which are now occupied to very little advantage. This will not in all probability happen until the use of machinery is more appreciated in Surrey than at present.

One of the changes which must be mentioned is the growth of green crops before season turnips. But this is an improvement which must not be recorded as such without mentioning the objections as well as the advantages of its practice: it is no doubt a step in the right direction, but at the same time it is attended with evils which have prevented many of the best farmers in the county from adopting it. Upon the early soils there is no doubt that it frequently answers to plough up the wheat stubbles and plant some kind of green crop; and supposing the crop to be drilled it can be hoed, and the land kept clean without lying idle; and if the crop be folded sufficiently early in spring, there is yet time to fallow the land (which seems indispensable to its being kept clean), and to sow the season turnips in good time. Under the most favourable circumstances therefore this practice may be followed without detriment to the succeeding crop of roots; but these favourable circumstances cannot always be secured. After a late harvest, for instance, the sowing of the green crop is thrown back, the whole process is retarded, and consequently complaints are loud the following autumn that the root crop has suffered, and that the feed which was gained in the spring does not compensate for the loss of several tons per acre of the succeeding crop. It is from the injudicious application of this system that many farms have been thrown out of condition, their occupiers disgusted with the practice, and incredulous neighbours made more prejudiced than ever. The writer has known of instances where more capital has been required to restore a farm to good "heart" than could possibly be gained by the extra crop. It is impossible to lay down any fixed rule upon the subject, since a farmer must always be guided in his operations by the times and seasons. It will be seen by referring to the description of the farming of the light-land districts that the cultivation of a certain portion of the fallow for the purpose of winter and spring feed for cattle and sheep is universal. The result of experience seems to prove that many of the early soils are peculiarly adapted for the system just alluded to, and that in a favourable season it can be followed to advantage, but that under unfavourable circumstances the loss to the succeeding crop will be greater than the benefit apparently gained.

When we observe the great change which has taken place in the increased quantity of stock which is fattened now, compared to that which was sent to market 40 years ago, it is difficult to

conceive how the demand could have been supplied if the introduction of the turnip-cutter had not facilitated the maturity of sheep. This circumstance has completely falsified an observation of Stephenson's, which, in his day, was no doubt perfectly correct, but which modern ingenuity has disproved. Comparing the swede with the common turnip, he says, "during the winter they are not considered as equal feeding to turnips; they are then harder, drier, and tougher; of course they are not so much relished; the cattle or sheep cannot fill themselves in so short a space of time, or with so little trouble as they can on the common turnip, and therefore will not fatten so kindly or so soon on them." This is only one of the numerous instances which could be cited of mechanical skill having wrought a complete revolution in husbandry; science has already taught us the reason of many things, and has also become the best guide to practice. When therefore we remember the benefit which has been conferred by modern inventions on all the important operations of husbandry, and observe the scientific research which is directed to this branch of industry, who shall despair of still greater advantages yet to follow?

The preceding pages have shown that Surrey is by no means remarkable as an agricultural county. There are no great breadths of land where an uniform system is carried on; there are no extensive tracts which have been reclaimed or improved by artificial means; there is but little breeding of stock; there is nothing in short of especial interest either in the produce or the modes of cultivation. It is but just to remark however that all the operations connected with the mere tillage of the ground are well performed; the implements are generally of good construction; the varieties of the crops, whether of corn or roots, are carefully selected; and the breeds of stock, and more especially of sheep, are well chosen. The application of machinery is greatly neglected; this may be partly accounted for in many localities by the number of homesteads and the scattered position of the fields; still much might be done to lessen these inconveniences, although to a certain extent they must always exist, and the greatest and most obvious improvement which can be effected is the centralization of the farm-buildings and the application of machinery for general purposes.

In conclusion, the writer has great pleasure in returning his sincere thanks to those gentlemen who have afforded him much valuable information from every district, and without which a Report possessing any claim for accuracy could not have been written.

February 26th, 1853.

XXVII.—*On the Bean-Turnip Fallow.* By the Rev. Th. Burroughes.

I do not know how to assign a more appropriate name to that particular system of cultivation, which I am about to recommend after five years' experience; trusting that I shall be able to prove, that by the regular adoption of this course on a fourth part of the fallow, a considerable increase of profit will be obtained, on a mixed soil or turnip-land farm under the four-course husbandry, without the slightest injury to the subsequent crops. I am, however, well aware that I cannot aspire to any pretension of *novelty* with regard to this plan; for, though as far as I can learn, it has only been adopted by myself in this part of the country, I have since seen in Mr. Pusey's paper (Journal xxvi., p. 427) that it has already been practised to some extent in other parts. My aim, therefore, is more fully to explain the details of this method of cultivation and its expenses; to remove existing prejudices against it; to prove, by *example*, the advantages and *profit* arising from it; and hence to recommend it as a *systematic part* of the fallow.

My plan consists of having two rows of winter beans about 7 inches apart, and then a yard interval, in the middle of which is a single row of turnips; the average produce of the former, during five years, has been a little over three quarters per acre, varying from four quarters to two, though only in one instance so low; and the latter has invariably been a full half-crop, with both bulbs and leaves of a large size; the soil being in a great degree silicious, and of that kind which is commonly called "red land," of a fair average quality and depth, with various substrata of gravel, chalk, and red brick-earth, and, upon the whole, entirely different from what is commonly called "bean-land." It may be important to remark, that these beans have in no instance been attacked by the Aphis, or any diseases peculiar to beans, while in one of these years the ordinary *spring crop* in this part of the country suffered severely: but the last summer they were not exempt from that peculiar blight which was said to have affected the winter-beans generally, and I believe they were thus reduced nearly a quarter per acre, but still have yielded 3 quarters 2 bushels per acre.

For the first four years I grew the small dark Russian bean, which is said to have degenerated in this country from its original size; but last year *another kind* of bean, equally hardy, of a pale colour, and much larger size but similar shape, and with the peculiar property of branching much more from the root; and I believe it is so far more productive as to ensure an increase of at least 4 bushels per acre. I have been unable to ascertain the

proper name of this bean, but was tempted to try it by rather extraordinary accounts of its productiveness. I may here also remark, that under this system the beans are found podded so low on the stalks, arising no doubt from the free circulation of air through the wide intervals, that there is even some difficulty in getting them reaped sufficiently near the ground; and pulling would certainly be objectionable, on account of the loss of the stubble and root to the next crop. Instead of the intermediate turnips, I have sometimes had very fine crops of cole in this way, but have found it much less favourable to the barley crop; and I have twice tried the same on a part of the layer, or seed course, followed by wheat, which was however, as I expected, not equal to that after the layer; and on an occasion of a failing layer, I had a crop of green mazagan beans planted in the spring, with a fine crop of cabbages between, which were all fed off on the land: but here also the following wheat crop was not satisfactory; and though in this instance the produce of the mazagans was four quarters per acre, they are on these warm soils far less certain than the winter bean, often suffering too much from drought as a *spring* plant, and are moreover of inferior quality.

Next, with respect to the process of cultivation:—The first thing is to thoroughly clean a mown wheat-stubble by forking out all the couch-grass or twitch, docks, and other perennial weeds, the cost of which I have found varying from 1*s*. to 3*s*. per acre; I then spread equally over all the land about 8 loads only per acre of long loose manure from the yards, which in that state tends to keep the land dry and warm through the winter. I have had, however, in parts of my land without this assistance, some times nearly as good a crop. The manure is ploughed in rather shallow, and from 1½ to 2 bushels of seed is drilled, at the distances mentioned, as soon as convenient in October; nor is any time in November too late, though much less desirable. Early in the spring the yard intervals are stirred once up and down by a common plough, with a rather wider share than common and with the breast off, so as not to bring up the manure or move the earth from the beans, the horses walking a-breast, one on each side the beans, without requiring a leader; a narrow one-horse scarifier, made for the purpose, follows once over the ground, and completes the work of two ploughs. The whole of this process is repeated just before turnip-sowing, and then, on account of the height of the beans, it is necessary to have the two horses at length and a boy leader. The turnips are sown by a small hand-drill worked by one man—(manufactured by Holmes of Norwich),—a boy following him with an iron rake, drawn loosely over the ground. Two hand-hoeings, and one or two hand-weedings are given to the beans in the course of the season,

and the latter may be done or repeated even to the time of harvest, so as to leave the crop perfectly clean. The cost of the hand-drilling and raking is 8*d.* per acre, the bean-hoeing 3*s.* 6*d.*, and hand-weedings 1*s.* 6*d.* to 2*s.*, it being borne in mind how small a portion of the acre is thus dealt with. For the turnip-hoeing and singling 3*s.* 6*d.* only per acre is paid, the drills being at twice the usual distance. The beans are reaped and shocked just before the wheat harvest commences, at 4*s.* 6*d.* per acre. The crop is carried away without any difficulty in avoiding injury to the turnips, which sometimes do not receive their second hoeing till about that time. Precisely the same process as before, of ploughing and scarifying, is then applied once to that part of the land on which the beans stood between the turnips; then commences a most rapid growth of the latter, and the field presents the appearance of a perfectly clean turnip-fallow, with the rows 3 feet 7 inches apart.

Now, as to the cost of tillage.—It has often, upon a superficial view, been much over-estimated, and advanced as a serious objection, but it may be *truly* said, that no part of the fallow *in fact can well cost less;* for it will be found, by reference to the account above, that the total amount of ploughing per acre is, after all, only 2½ full-acre ploughings, and 1½ full-acre scarifyings, with one horse, and 8 loads of fresh manure, at half the cost of that which is twice turned and reduced fine by heating. Apart from this, the extra items of expense belonging to the beans have been enumerated above at 10*s.*, to which is to be added the cost of seed, drilling, carrying, stacking, and threshing—amounting altogether to 14*s.*; so making the total extra expense 24*s.* per acre, while the cost of the half-crop of turnips (4*s.* 2*d.*), it will be observed, is exceedingly low.

I confess that I originally, in accordance with the general opinion, expected some diminution of the following barley crop, and yet I considered I should be *compensated by the beans;* but I have, *in fact*, invariably found it equal to the *best* upon my farm, and considerably surpassing that after mangold with 12 loads of good rotten manure, the leaves being afterwards ploughed in; or that after tares, whether mown green or left for seed, and followed by turnips with artificial manure, or by cole or mustard, or that part of the general turnip crop *fed late* by a breeding flock. And this I believe is in a great degree to be accounted for by the *early* autumnal cleaning and ploughing the whole land for the bean seeding, and also the following autumnal ploughing of that part on which the beans were grown, and taking the turnips in the first part of the course for the breeding flock, with cut hay and straw, though without any other adjunct; also by the long manure remaining to some extent unexhausted, and moreover by

a bean stubble being favourable, according to common opinion, to the growth of barley. At all events, all gainsayers have found, from personal inspection of the crops, a full answer.

With respect to the turnips, my experience leads me to remark that the space of 2 acres will thus maintain a ewe-flock of about 12 score for a week; or, what may be more desirable, about 10 score of fatting sheep, with a pint of beans each a-day, and which will thus consume just one-half only of the beans produced upon the land. I have grown different varieties of turnips in this way, but it is particularly adapted to the Tankard, which requires a wide space, and thus reaches a great size.

Amongst other objections against this system the *chief one* has usually been put in the form of a question, "Why not have at once a full crop of beans on one-half of the land and a full crop of turnips on the other, instead of your mixed crop?" The answer seems to lie at the foundation of the system, and it is *this*:—"taking, for instance, 2 acres; the first, with the beans only would thus be *no fallow* at all, and any increase of the bean crop would be counterbalanced at least by an equal decrease of the barley; and, moreover, it is not so certain that the former would take place as that the latter must. Again, on the other acre, if the full crop of turnips should be followed by the increase of a quarter of barley, I should only have this said quarter of barley to compensate me for the loss of 3 quarters of beans; while, with regard to the turnips, it is obvious that the *total* amount could be no more than that of the mixed crop on 2 acres.

There are also *other* modes of cultivation which have been successfully applied to winter beans and turnips; and an account is given in Journal, No. xxix. p. 63, of a large produce both of beans and turnips grown in single alternate rows 27 inches apart —I know not whether on ridges—but "on a deep black gravelly soil," no doubt superior to mine; and I had myself thought of this plan, but I considered that the land could not be thus so perfectly cleaned where annual weeds, as here, so much abound; also, that on flat land it would be difficult to prevent the horses trampling on the rows of beans set so close, and that the bean-stalks would be much more apt to be snapped by the high winds which prevail here; moreover, that the turnips would be more difficult to set out, and would suffer more from the trampling of the reapers. But the recorded result is enough to induce me to make the experiment on a part of my next crop.

Another plan, which is recommended by Mr. Pusey himself in the Essay before referred to, is to have a whole crop of winter beans followed by turnips; but the bean stubble would thus have all its usual foulness, and much cleaning would be perhaps

required for the turnip crop beyond a single ploughing, and all this at the busy and expensive time of harvest, as in this part of the country the winter beans are not ready for cutting till a few days before the wheat, and, with the utmost exertion, the turnips could not be sown till August, and then an acre of such a late crop would produce less bulk than an early-sown half-crop between the beans; for a turnip crop here sown even in the latter part of July is not much to be depended upon, and never comes to much size. But the greatest objection, which remains, is that the bean crop, and afterwards the turnip crop, being dispersed over *the whole* of the land, must necessarily cause a greater exhaustion of the soil than where there is only a turnip crop on one-half and a bean crop on the other, followed by a ploughing and scarifying, and no turnip crop succeeding.

In estimating *the value* of this mixed crop, I trust it will be understood that it would not be reasonable to put it in competition with a full crop of swedes, mangold, or cabbages; for it is by no means meant to imply any reduction of those more important crops, but all of which, requiring larger quantities of manure, are necessarily limited in some degree according to the supplies on the farm, and are moreover, in fact, only desirable and convenient to a certain extent. Supposing, then, that even half the fallow, if practicable, should be devoted to such crops, and a quarter to the growth of rye and tares, in about equal proportions, the first being followed by common turnips, and part also of the latter by the same, and the later mown parts, it may be, by cole or mustard—the *bean crop* is meant to supersede the remaining quarter, which would be common turnips, to the extent of a diminution of one-half. Thus, on a general fallow of 100 acres, the bean-turnip crop would occupy 25, and would thus displace 12½ acres of turnips; if, therefore, on an average of years the general value of the latter, according to common opinion, is 2*l.* per acre (and which my own experience would assign as the utmost), the loss to the farm would thus be 25*l.*, and the extra cost of the beans being, as before stated, 24*s.* per acre, the total extra expense so incurred would be 30*l.* We have, therefore, an amount of 55*l.* to set off against the value of the beans.

Now, the bean crop averaging 3 quarters per acre, at 30*s.*, amounts to 112*l.* 10*s.*, and the straw, estimated at least at 6*s.* per acre, to 7*l.* 10*s.*, so making a total of 120*l.*, and deducting from this sum the amount against it, there remains *a clear gain* of 65*l.*; and it ought to be observed that 1 quarter per acre more or less would increase or decrease this sum to the amount of 37*l.* 10*s.*; and on the better sort of mixed soils who can doubt an average of 4 quarters, and a consequent gain of 102*l.* 10*s.*?—and, on the other hand, if in some seasons or on some lands the

produce should be only 2 quarters per acre, there would be no loss, but still a gain of 27*l.* 10*s.*

I may observe further, that *the accommodation* of the bean straw is a matter not to be overlooked on a farm where there is but little grass-land; and it also enables the farmer to reserve a larger portion of his clover crop for seed. And it is, moreover, a fact of no little importance, that the whole, or at least nearly the whole, of the horse-corn required for the farm may thus be supplied out of a *fourth part of the fallow*, if it should be desirable so to apply it. There is also another mode in which some portion of the crop may be *very profitably* applied, and that is, pulling it in a green state for the pigs in the yard, for six weeks or more before it is ripe, and even some time after; they have then the whole benefit of the stalk as well as of the bean, and consuming every part of it, they thrive well: and this mode of keeping them is found very convenient at that rather difficult time previous to their going to shack.

In conclusion I beg to be allowed to observe, that in treating on this, confessedly my favourite agricultural topic, I hope I may have escaped the charge of any tendency to enthusiasm, or to the slightest degree of false-colouring, anxiously desiring only to speak the words of soberness and truth; and if I have succeeded in explaining how a large increase of *profit* from the fallow may with certainty be obtained, and that without any deterioration of the land such as arises from other crops commonly grown on the fallow, and have also proved the same by my own recorded *experience of five years*, I trust that my pen will not have been employed in vain; but that it may be happily instrumental in inducing others to adopt this course as a *systematic part* of the fallow—not, however, forgetting the *sound principle* which was enunciated by Mr. Pusey (Journal xi. p. 421), that "it is not what is *grown on* the farm, but what is *sold from* it, which impoverishes it."

Feb. 26, 1853.

XXVIII.—*On Improving Grass Land, &c.* By Richard Milward.

To the President.

Dear Mr. Pusey,—I promised to send you a statement respecting the plan I have pursued in improving grass land.

The fields in question had been laid down in grass many years ago, in small ridges or lands from 4 to 8 yards wide. There was no spring-water, but the land was wet, because the rain-water could not get away through the retentive subsoil. I

found the only effectual plan was to put a drain in every furrow 2 feet deep, for, if only in alternate ones, although in some cases only 8 yards apart, the water would stand in those undrained. After draining, I applied 7 cwt. salt per acre, and in a few months about 12 to 16 bushels dissolved bones, or 2 cwt. Peruvian guano. The effect has been wonderful, as two years ago the fields were ordinary store land, and this summer have fattened a short-horn heifer on each acre. I have not found much difference between bones and guano, but I think the animals prefer the latter. They should be applied to the land between Nov. 1st and Feb. 1st, but the nearer the first-named time the better.

I have another communication to make to you respecting growing swede turnips on strong clay land, with only one ploughing. I think I have made a discovery by which much labour is saved, and a good crop far more certain (at least if the same plan is pursued by others, I have never heard of it); and I think it of so much importance that I trouble you with this long letter.

As soon as the corn is cleared from the land intended for turnips, the stubbles are pared with Glover's paring-plough. This first-rate implement leaves the land in small ridges, so that, when harrowed over, all the grass and weeds are very easily got out, and the land is perfectly clean; 20 cart-loads of manure are then spread on each acre, and ploughed in. The land is not touched again till April or May, and then it is merely harrowed once with very light harrows, and the turnips drilled (on the flat) 30 inches wide, with 2 cwt. Peruvian guano or superphosphate per acre.

I have now 90 acres which I have just begun to pull, all treated as above, and, excepting a small part of two or three fields (not exceeding 10 acres in the whole) which was manured and ploughed when too wet, I think it would be difficult to find the same weight on the ground.

I have not yet weighed the produce, but some of the fields are estimated at more than 30 tons per acre, and many of the roots, when cleaned and free from top, weighed 12 or 14 lbs. each in September.

I feel sure that this plan only requires to be tried to be generally adopted; but it is absolutely necessary that the land should be kept free from twitch.

Believe me, yours very truly,

RICHARD MILWARD.

Thurgarton Priory, Southwell,
Oct. 14*th*, 1853.

XXIX.—*New System of Irrigation.* By Joseph Druce.

To the President.

Dear Sir,—The first season being nearly passed since you recommended me to make a trial of Mr. Bickford's method of irrigating, I have thought you would like to know the result of the experiment.

I had two plots of land laid out of about 4½ acres each.

The first was on land in ridge and furrow shape, the sizes of which were small, so that more cost was required to lay it out, trenches being wanted both at ridge and furrow. The supply of water is had from two yard ponds, and a liquid-manure tank connected by a pipe-drain of 70 yards long, to convey it to the main trench; and enough can be got from once emptying the tank and ponds to flush an acre; and I have found between 50 and 60 hogsheads sufficient for that purpose.

The farm buildings are on a hill, so that when the plug is taken from the pond, a man pumps at the tank and the water is nicely diluted for the purpose, and the flow is steadily distributed by having a man on the spot to regulate the flow by stops in the trenches. The result on this plot has been satisfactory, for I found the grass grow much earlier in the spring than it did before; a greater quantity was produced in the summer, and evidently now the quality is much improved.

The other plot has not been so marked in its improvement, which I attribute to pond water only being used without any liquid manure; there was, however, a greater crop of hay on it than where no water was used; and I believe if I could command more water to flush with a corresponding benefit would ensue.

The cost of the outlay for laying-out was 15*s.* an acre, and 10*s.* an acre more for extra labour in removing the turf from the trenches and levelling the ground, and pipe-tiles to convey the liquid from the homestead; and I believe the future annual cost to put it in order for irrigating will be from 2*s.* to 3*s.* per acre.

The great advantage this system has over the old method is economy of water, requiring but shallow and narrow trenches instead of wide and deep ones, thereby making a small quantity go over a large tract of land; a very small loss taken up by the trenches, for I find the grass grow in most of them, and they are not of a size to hinder the usual occupation of using the haymaking machine and carting across them.

It has only to be more generally known, and this system will be followed, and I believe found beneficial and useful, in applying water from small streams to enrich adjoining lands, where it is often found rich with the washing from the soil near.

I am, dear Sir, yours most faithfully,

J. Druce.

Eynsham, Oxon, Nov. 11, 1853.

XXX.—*Farming of Herefordshire.* By Th. Rowlandson.

Prize Report.

The County of Hereford ranks amongst the least considerable of the English counties, so far as superficial area is concerned, and owing to its purely agricultural character possesses the smallest population in proportion to its extent of any county, with the exception of Westmoreland—the bleak and dreary moors and mountains of the latter district sufficiently account for the different proportions—Herefordshire possessing a population amounting to 128 individuals per square mile, whilst Westmoreland only contains 74 individuals on an equal space. As to the number of persons engaged in agriculture in proportion to the entire population, Hereford exceeds all other counties, and may consequently be deemed the purest agricultural district in England. The ratios here drawn are taken from the Census of 1841, the returns for 1851 not having yet been published, owing to the unfortunate fire at the printing-office of Messrs. Clowes and Sons.

According to the returns alluded to, the entire population of Herefordshire amounted to 113,878 persons, of both sexes and all ages. Of this number, 16,213 persons were actively engaged in agricultural pursuits, and 11,265 do. in trade, commerce, manufactures, &c.

The Character of the Soils and Subsoils of the County.—The total area of the county of Hereford, according to the trigonometrical survey, is 543,800 statute acres, the largest proportion of which is occupied by the rocks known as the old red sandstone. To a casual observer, especially if he happens to traverse the district by the principal mail-coach routes only, the whole county presents the appearance of one continued mass of red soil, superposed on a silicious red sandstone rock. Freely admitting this feature as forming the principal characteristic of the surface soil of Herefordshire, it nevertheless admits of many modifications, interesting not only in an economical point of view to the agriculturist, but also in a scientific one to the geologist. To no district in England could the student in agricultural geology better direct his attention than the one now under consideration. It does not possess the grand and wild features presented in the contiguous mountainous district of South Wales, with its violent contortions of strata, abrupt precipices, and Alpine heights: but to compensate for these more striking circumstances, the sylvan and pastoral beauties presented in an excursion from the Malvern Hills, across the Woolhope district to Hereford, will form a not inadequate recompense. In traversing this district from the points indicated, the way-

farer will have ample opportunities afforded him of studying the formation of soils and their varied characters, according as they are formed solely from, or in admixture with, decomposing plutonic rocks (as in the Malvern range), the old red sandstone, and the different strata of the Silurian system. The modifications caused in the character of soils by the agency of limestone is well exhibited around Woolhope, owing to the somewhat extensive surface development of the Silurian limestone in its vicinity. At the north-western corner of the county, near Presteign and Kington, and a considerable district around Wigmore, in the extreme north-western part of the county, the soils are principally composed of loose calcareous and sandy gravels, the bottoms, however, not unfrequently form rich pasture grounds.

The richest soils in Herefordshire are found resting on that division of the old red sandstone known as the "cornstones," owing to its containing a considerable amount of granules and nodules of impure limestone called cornstones, whose chemical composition varies, being sometimes composed of alumina and lime alone, at others containing magnesia also in combination. Practically it is found that wherever decomposing cornstones become admixed with the silicious sandstone rock, a perceptible improvement takes place. A remarkable instance of this is exhibited in the long valley lying at each side of the small river Dor, of which Turnaston is about the centre. This valley lies between two contorted ridges, of which the cornstones constitute a more than common proportion, the alluvial soil washed down from the surrounding hills has formed at their base a soil so luxuriant that it has obtained the title of "The Golden Valley."

Generally speaking, the rocks composing the old red sandstone, and situate in Herefordshire, are easily decomposed by atmospheric agencies: the exceptions to this rule principally consist of the upper series of quartzose conglomerate and sandstone, which compose the elevated ridges towards the western margin of the county. In such places the soil is sharp and light, consequently not very productive, being principally occupied in grazing a small breed of sheep with fine wool, something in character between the Ryland and Radnor. That the highly silicious character of these rocks has much to do with the infertility of the soil formed by their decomposition is certain, but secondary causes prevail to render that sterility permanent, which otherwise might be greatly modified and alleviated. Although the general physical position of these rocks is elevated, and they are as an almost necessary consequence more exposed to the slow decomposing action of atmospheric agencies, the abruptness of the declivities gives such an impetus to the action of the offlowing rain-water, that the finer

particles of oxide of iron, alumina, and other substances, which, if allowed to accumulate, would form a rich soil, are at once and as rapidly as they become sufficiently disintegrated, carried into the vallies at every recurring heavy rainfall.

Were many of our richest vales submitted to as powerful a degrading influence as prevails on the silicious uplands just noticed their rapid deterioration would speedily be seen. In place of which, under existing circumstances, the vales receive annual additions from the comparatively contemned uplands, which enable the former to maintain that perennial fertility which is so much desiderated and admired. It will thus be seen that physical position exercises an influence on the character of a soil formed from any given rock equal to that of its mere geological character, a fact sometimes lost sight of by parties who treat on agricultural geology, the importance of which, however, must be apparent when pointed out to any reflecting mind. Owing to a neglect of the consideration just noticed has arisen the difference of opinions, as to whether soils are similarly composed with the rocks which they overlie. Generally the soils in Herefordshire are similar in composition to the underlying rocks, and this rule perhaps holds more truly of the soils of Herefordshire, than of those of any district in England, of equal extent. But this is not wholly true: the most striking example to be adduced is that of the gravelly soil around the city of Hereford, whilst all the most fertile flats will be found on examination to contain substances transported from places other than those in their immediate neighbourhood; even amongst soils which to all superficial appearances resemble the underlying and prevailing red sandstone rock.

With exceptions about to be noticed in connexion with the protrusion of rocks connected with the silurian series, the general characteristics of the soils of Herefordshire may be classified as shallow argillaceous loams, deep argillaceous loams, and sandy loams, the whole partaking of one generic colour, namely, that of a deep red. Occasional diversities are, however, to be found, in consequence of the existence of local coverings of drift and silt, principally composed of coarse gravel (the débris of silurian and trap rocks) which have been transported from the west and north-west. In some cases the gravel is of a somewhat comminuted character, in which instances the soil is moderately fertile. The areas most altered in this respect are those in the vicinity of the cities of Hereford and Bromyard, in the neighbourhood of which latter place the prevailing red colour of the soil is obliterated in many parts, owing to the amount of the drift just alluded to.

The usual distribution of the old red sandstone rocks in

the Silurian system is into three, and in the district under consideration, the geological features correspond with the agricultural character of the superposed soils. Thus the upper division of the old red sandstone is rocky and silicious. Its most infertile aspect is to be seen in the vicinity of the black mountains. Even in this bleak district a considerable amount of good land is to be found, owing to the same convulsion which upheaved the quartzose upper beds having at the same time caused the middle or cornstone group to crop out in many adjacent parts, so that the mixture of the débris from each has formed a kindly though not very deep loam. In the large flat sandy district, of which the town of Ross is nearly the centre, and which occupies nearly the whole of the southern part of the county, and extends from the county of Gloucester to Monmouth, no such countervailing advantage exists, and the result is seen in a light sandy district which has obtained the title of "The Ryelands," owing to its not being capable of growing with equal advantage any other crop than rye. From the fact, however, of its being very level, and possessing no great declivities, the abrading and impoverishing effects produced by rains is not here seen. Almost adjoining the district just noticed, and immediately to the northward, is the small tract of gravelly soil around the city of Hereford.

Surrounding the last-described district, and occupying a full third of the county, is the middle or cornstone division of the old red sandstone. The decomposition of the calcareous nodules, when intermixed with the ferruginous and argillaceous particles of the accompanying rocks, forms the rich red marls and soils of Herefordshire; and when a fair proportion of sand accompanies these substances, a fine open loam is formed, on which the most luxuriant crops of wheat and hops are produced; this soil also bears the most prolific apple and pear orchards. On the whole of the district in which the cornstones prevail, more especially in such places where the soils partake of a heavy character, the finest and freest growing oaks in England are to be found growing. In fact, so much do these trees abound, that they have been termed the "weeds of Herefordshire."

Intermixed with the middle section of the old red sandstone group just noticed, are two small divisions of silurian rocks, one around Woolhope, and the other stretching from Ledbury to the Malvern Hills; the latter is covered by the most argillaceous soil of the county, whilst the stiffness usually resulting from this circumstance is greatly modified in the Woolhope district, owing to the greater surface-development of the silurian limestone.

From what has previously been stated, it will be seen that the general character of the subsoils of this county participate largely in

the qualities found in the active surface soils. Thus, in the upper beds of old red sandstone found to prevail at the western part of the county, the surface is sandy, with only a light vegetable covering, whilst the subsoil is composed of a rotten, silicious stone or rubble at greater depth, frequently partaking of the nature of a gritstone rock, sometimes sufficiently hard for building purposes. The central or cornstone group of the old red sandstone gives rise, by the disintegration of its constituents, to a more argillaceous soil; a character somewhat more apparent than real; for, if analysed, it will be found to contain far less alumina than a casual inspection would suggest, the "stiffness" being in a great degree attributable to the finely-divided state in which the calcareous particles and peroxide of iron exists, giving to the whole a paste-like consistence when saturated with moisture. Although the term aluminous has been used previously in describing the soils of this district, the expression must be understood, both in the past and in any future observations, as being given rather in a conventional than in its actual or strict meaning; its use being adopted to indicate a soil of a "stiff" and somewhat retentive character, rather than as describing any relative chemical composition. A very large area of the land of Herefordshire which is situate on the cornstones is confined to pastoral husbandry, to which it is best adapted, in the absence of a perfect system of drainage. The natural accumulation of carbonaceous matters, and their gradual intermixture with the finer earthy particles, eventually causes the sward to assume the character of a rich friable mouldy loam, the subsoil, however, being generally deep, cold, impervious, and retentive.

The lighter soils of the county are mostly in the flat districts situate upon the lower members of the group, and are generally of a less fertile character than those covering the cornstones; in few cases, however, are they so sterile as those already noticed, which are placed on the upper series; indeed, when, as sometimes occurs, an outcropping bed of marl makes its appearance, strips of fine land are found as the constant concomitant. A rotten sandstone rock or breccia is the general subsoil on the lower rocks; sometimes, however, where the decomposition of the rock has been complete, deep beds of sand and fine gravel are found. The subsoils on the silurian rocks near Ledbury and Woolhope are frequently stiff, excepting where the limestones prevail; those near Presteign are porous.

The Use of Lime as a Manure, &c.—Like all districts where lime can be obtained in abundance, its abuse is much more apparent than its judicious application; the introduction of artificial manures has, however, done much to lessen the evils of over and too-frequent liming. The concretionary limestones of

the cornstones are so abundant that scarcely any part of the central districts of Herefordshire can be found where limekilns are not numerous; as previously remarked, however, these limestones possess an earthy character, and are not considered so powerful in producing fertility, especially on stiff soils, as lime made from the carboniferous or mountain limestone; it is not uncommon, therefore, to find the farmers sending for the latter, when at all within convenient reach, in preference to employing that which can be plentifully supplied in their own immediate vicinity. The policy or impolicy of this plan will be discussed hereafter, when the general subject of liming is taken into consideration. It may, however, be incidentally remarked that, according to the texture of the soil, the mechanical action of earthy lime may be advantageous or otherwise. Thus earthy lime may be found more beneficial on silicious soils, owing to its adding aluminous substances thereto, rather than the purer limes obtained from the carboniferous limestones, whilst on a stiff soil the latter may prove most effective by rendering it slightly more open. The cohesive tendency of argillaceous limestones has frequently been remarked: in fact, in degree, they are hydraulic or water-cement stones. Thus, in Mr. Duncumb's Report, it is stated, as the observation of a shrewd and observant farmer, "that lime ought to be put on the land some days at least before the sowing takes place, otherwise, in wheat crops, it will cause the ground to ferment, and lie too closely round the seed during the winter; or in barley crops, it will prevent the growing of many of the grains if hot weather immediately succeed the sowing." Although it is not stated whether earthy or carboniferous lime is here alluded to, the fair presumption is that the former is meant, as the action is precisely such as might be anticipated, namely, the formation of a hydrated double silicate or aluminate of lime, which, hardening round the grain, prevented its growth. Although chemistry was very little understood at the time the above was written, namely, more than half a century ago, the true *rationale* did not entirely escape that sagacious observer, Mr. Knight, who remarks that the action of lime will depend much upon its quality. If it be found to contain much flint and sand, and probably (when in mortar it sets readily under water) some manganese,* Mr. Knight observes, "that it may be ploughed in hot, and immediately before the sowing, even in large quantities, without injury; but in other lime, and particularly in that which contains a proportion of magnesia, more caution is necessary." Mr. Knight was

* This is an error of Mr. Knight's, as it is not manganese that gives the property of mortar setting under water, but silica and alumina; magnesia may also be present. The remark of Mr. Knight, however, shows that the cornstone lime was meant.

also of opinion, that lime, often repeated, will render no service to an exhausted field although it is very frequently applied—an opinion in which every one must agree who has paid the slightest attention to the practical application of lime for agricultural purposes. Before leaving the subject, a few words will be added on the general *rationale* of the application of lime as a fertilizer. Of the abuse of lime, and the compulsory clauses not unfrequently introduced by landlords or their agents into agreements with tenants, it is well observed by Mr. Knight—"Thus the landlord who binds his tenant to a large consumption of lime, without stipulating for the use of other manures, resembles the man who lets his horse to hire under a positive injunction, that the rider shall use whip and spurs, but takes no precaution to insure the equally-essential requisite of an abundant supply of corn and hay, without which the exertions of whip and spur must be utterly unavailing." Prior to entering on the general subject of liming, the following extract may be read with interest, as it presents some features worthy of notice; the writer proceeds to observe—

"In whatever way lime is applied, the succeeding crop or crops receive more benefit from a hot than a cold summer. Wheats on fallows, limed during the spring or summer previous to their sowing, seldom appear better than on unlimed lands under similar husbandry, until the weather becomes hot in May or June.

"Grain of all sorts on limed lands is later in getting ripe than on those where no lime has been used. When large quantities are applied this effect is particularly discernible. Hence I infer, that lime has a tendency to make the land cool, perhaps by exciting or attracting more moisture; and I never recollect (proceeds the writer) to have seen a crop suffer from a dry hot summer when the land had been previously well limed."

In the absence of full information as to the exact character of the soil on which these observations were made, it would be vain to reason upon all the phases of the previously-recited positions. It is, however, by no means difficult to understand that crops will be generally found more productive in a hot than in a cold season. The assertion that liming land retards the ripening of cereal crops is certainly contrary to all the writer's experience, whether as regards Herefordshire or any other part of the United Kingdom, if an exception is made for excessively poor and worn-out soils; on a comparison with such, it may happen that the crops on the limed land will be found to ripen somewhat later owing to the crops on the impoverished land seeding prematurely.

The great cause of liming proving beneficial to land arises

from its property of neutralising those brown acids which form soluble salts with the alkalis, potash, soda, and ammonia, but insoluble ones with lime, magnesia, and the other earthy bases. Whether a soil wants liming may be easily ascertained by placing a little of the soil in a wine glass, with some dilute "liquor ammoniæ," "spirits of hartshorn" as it is commonly called; if the liquid becomes perceptibly brown in a few minutes the land will require liming; if it only assumes a very light tint, after remaining half an hour, no liming will be of service, unless the soil has never been limed, and is deficient in that substance; the latter is a rare case. Owing to the flatness of many parts of Herefordshire, and the retentive character of its soils, the acids here alluded to do accumulate and render the occasional use of lime not only proper but also advisable. What is beneficial in one place is inimical in another, and that which may prove occasionally remunerative on the heavier soils of the cornstones, especially after having lain long in pasturage, will be found of no effect and unremunerative on the silicious soils of the rye lands.

The introduction of artificial manures has greatly diminished the use of lime amongst the farmers of Herefordshire; but it is to be regretted that the conduct of unscrupulous dealers in palming off spurious articles as manures upon the farmers of this county has greatly retarded their more general application. Wherever genuine portable manures have been employed in Herefordshire their use has been attended with the most marked success, and in so far as high farming has been carried out by their employment the use of lime has been gradually circumscribed, with profit to the farmer, not only in diminished cost of production, but also by the growth of more luxuriant crops. The extension of arable cultivation in Herefordshire is mainly dependent on the future facilities which may be afforded for obtaining portable fertilizers at a moderate cost, for there is not a county in England where their employment can be made so profitable to the occupiers of the soils over so wide an area in proportion to its extent. Few would be found to lime, excepting on raw turf bogs, if they could obtain a sufficiency of farm-yard manure; it may consequently be inferred as a general rule that the use of lime is diminished by high farming.

Manufacture of Cider and Perry.—The general features connected with the manufacture of perry differ little from that of cider, it being understood however that the former is made from the juice of the pear and the latter from that of the apple. One of the earliest treatises on the manufacture of cider was that of the Rev. Francis le Couteur, of Jersey. But Marshall

also had previously given very full details in his 'Rural Economy of Gloucestershire;' the best article which has appeared in more recent times is that of Mr. Falkner, in the 4th volume of the Journal of the Royal Agricultural Society of England. It is intended in the first place to give a synoptical view of cider making, and afterwards enter upon the special management required for the perry manufacture. In doing this it is not meant to enter upon every minute manipulation, a large part of which is not only well understood, but is also to be found more or less in full in the treatises written by the authors already named. It is contemplated only to give such details as are requisite to the due elucidation of the subject, rather than an exact descriptive account, thus leaving space to dwell more fully upon points of management where it is probable that improvements may be effected.

In Herefordshire the ordinary mode of gathering the fruit is by sending men to beat the trees with long slender poles or rods, which are sometimes armed with iron hooks to enable the labourers the better to lay hold of and shake the branches of the trees; these poles are provincially termed "polting lugs." Women afterwards follow with baskets for the purpose of picking up the fruit, who, according to circumstances, carry the apples or pears at once to places selected for their deposition, and there arrange them into small heaps, or, as sometimes is the case, empty their baskets laden with the fruit into a cart employed for its reception, by which means it is at once removed from the orchard; in either case however the fruit is permitted to remain in heaps for some time in order to mellow; seldom less than 3 weeks are allowed for this purpose, often much more. As fruit on the same tree differs in the time of ripening, and consequently possesses unequal qualities, careful persons go over the trees twice, once with a hook when the spontaneous fall takes place, leaving such of the fruit to mature as will not quit the boughs with a gentle agitation; and a second time with "polting lugs," when the remaining fruit is sufficiently matured, or winter is likely to set in. The fruit heaps are allowed to remain for a period, the length of which is decided by the state of ripeness, generally however in Herefordshire the heaps remain a much longer time than is necessary, often until part begins to decay, in which case the production of a really fine-flavoured liquor becomes impossible. It is not deemed necessary in the present instance to describe the mechanical operations of grinding the apples into pulp and pressing the juice, but to confine the observations to the more difficult part of the manufacture connected with the fermentation, &c. It may, however, be well to observe that the mill of Hereford differs materially

from that used in Devon; in the former the mill consists of one, or, in some instances, two solid stone rollers, termed "runners," which revolve on a stone trough, called the chase, the latter being generally from 18 to 20 feet in diameter, the runners, being about 5 feet diameter. In Devon the crushing is usually done with rollers. The Hereford mill resembles a common mortar or cement mill, and a pictorial sketch of it must be familiar to many as exhibited in the advertisements annually sent out to their customers by the different cider merchants in the metropolis and other large towns. It is conceived by some that the flavour and quality of the cider or perry is much improved by leaving the mass of crushed fruit for 12 or 24 hours prior to sending it to the press. An aroma and preserving power is thus supposed to be acquired from the broken skins and pippins, which it is said that otherwise it will not attain. In either case the juice, after expression, is carried to casks, where in a few hours fermentation spontaneously commences, on the due management of which the subsequent strength and quality of the cider or perry depends. The expressed liquor, as it issues from the press, is a turbid brownish liquid, luscious and sweetish in taste, but far from inviting in appearance. The coarsest of these impurities speedily becomes separated from the body of the liquor, after the commencement of fermentation; being partly discharged in the form of scum which issues through the bunghole along with the first yeast which is discharged, and partly as a dense sediment or lees which gradually settles to the bottom of the cask as the activity of the fermentation subsides. When the cider becomes clear it is racked into a second cask, and in the majority of instances no further trouble is taken with it. The liquor so crudely prepared will, however, continue to ferment for a long time afterwards, or in fact so long as any saccharine matter remains to be converted into alcohol. For commercial sale, it is however generally considered desirable to retain a considerable amount of sweetness in the liquor; in order therefore to check the fermentation it is repeatedly "racked," or drawn off from one cask into another. On the careful management of this process the "body" or sweetness, as well as the flavour, will be found to depend; in some cases the same end is obtained by employing a sulphur match. These matches are made of linen or woollen cloth, about 10 inches in length and an inch in width, and are thickly coated with sulphur for about 8 inches of their length, by repeatedly dipping the strips into that substance when heated to liquidity; previous to its employment every vent in the cask is tightly stopped, except the bung-hole; the match is then kindled and lowered into the cask, being held by the undipped end until well lighted,

when the bung is driven in, the cloth being wedged in between the bung and the stave. A more effective plan is to allow 8 or 10 gallons of cider to remain in the cask, then to suspend the match and occasionally agitate the liquor, withdrawing the bung at intervals for the admission of fresh air; in this way the sulphurous acid becoming absorbed by the liquor in the cask to any amount that may be considered desirable, the cask can afterwards be filled up with unsulphured liquor. The effect produced by sulphurous acid is somewhat analogous to that of tannin, namely, rendering the soluble gelatinous matter present insoluble, and appears also to possess a property similar to that of several essential oils in arresting fermentation and decay.

It is seldom, however, that these measures are resorted to in Herefordshire, excepting in cold years, when the liquor might possibly be converted into vinegar unless the fermentation were stopped in due time; for in common with most, indeed we may say all the cider-making districts, the Herefordshire labourers, the principal consumers, dislike cider of a sweet character; excepting therefore in ungenial years, the liquor is allowed to take its own course after being once, or perhaps occasionally twice racked. In this way almost all the sugar in the "must" or juice is converted into alcohol, making the beverage known as "dry" cider. If this was all that took place the process would be perfect, but owing to a want of attention it also happens that a large part of the alcohol is changed into vinegar.

In the course of the observations immediately following it may be remarked that these processes are generic to the manufacture of both cider and perry, the former appellation is however used as being the most familiar one; previous however to the conclusion of the subject some special observations will be directed to the manufacture of perry.

Perry and cider, strictly speaking, are wines; the former is the produce of pears alone, the latter is either produced from apples alone, or from apples and pears jointly. The fermentation which gives rise to the production of these liquors is that ordinarily known as the "vinous," and is precisely analagous to that which obtains in the manufacture of wine from grapes.

The strength of perry or cider is dependent in the first instance on the quantity of grape-sugar (glucose) contained in the expressed juice; this can be judged with sufficient accuracy for ordinary uses by its specific gravity, an instrument called the hydrometer being employed for this purpose. If found deficient in saccharine matter, as generally is the case in cold years, sugar ought to be added, or grape-sugar might be prepared for this purpose. In good years no such auxiliary will be required to be added to the juice of apples, and still less to that of pears.

The spontaneous fermentation which occurs in the saccharine juices of fruits, such as grapes, pears, apples, &c., is owing to the presence of certain azotised compounds, which have received the name of proteine. Fermentation can only be excited in the first instance in the presence of the atmosphere or oxygen; when once commenced, it will continue until the whole of the sugar present is decomposed, although further admission of the atmosphere is excluded; alcohol and carbonic acid are formed during the process, yeast or ferment being at the same time produced. The yeasts yielded by the fermentation of beer, wine, perry, cider, &c., if examined under the microscope, and otherwise tested with alkalis and acids, will be found identical. Yeast once produced is not only capable of converting the remaining saccharine matter into alcohol, but, from its quality of absorbing oxygen, will change the alcohol (spirit) into vinegar. Hence the propriety of fermenting in close vessels, possessing only an opening sufficiently large to allow the escape of the carbonic acid evolved during the process. In "musts" (the juice of grapes, &c.) rich in sugar and proportionally poor in proteine substances, the decomposition of the latter becomes complete, and their separation in an insoluble form is effected by or previous to the conversion of the whole of the sugar into alcohol and carbonic acid. In such a case, if the liquor (now converted into wine) be carefully drawn off or racked from the scum and lees containing the residue of the ferment, and entirely excluded from the atmosphere, it will "keep" for ever. Such perfect exclusion of the atmosphere is, however, impossible; besides, it is known that alcohol is capable of evaporating through the pores of the staves that form the containing vessel. The reason why cider, &c., undergoes so many fermentations, notwithstanding repeated rackings, arises from the fact of the juice of the apple and the pear containing a proportion of azotised compounds susceptible of being converted into ferment beyond the quantity required to change the whole of the sugar present into alcohol; this undue proportion is increased in cold years. From this cause arises the rapid conversion into vinegar of cider and perry the produce of such seasons, and the necessity of employing, with proper precautions, saccharine substances from extraneous sources. In the juice obtained from apples and pears the proteine sources of ferment are always found in excess (less so, however, in the pear than in the apple) of the saccharine materials; it consequently becomes an important object, when the whole of the sugar has been converted into alcohol, to free the liquor from this source of spontaneous fermentation. This can generally be best accomplished by employing an infusion of tannin (the extract of galls, oak bark, &c.), which changes the

soluble gluten present into an insoluble flaky precipitate. This may appear a somewhat singular remedy; in commendation of the practice it may, however, be mentioned that in France it is sometimes found that wines deficient in tannin become viscid, or, as it is technically termed, "ropy"—a frequent disorder with champagne, owing to the mutual action of sugar and gelatine—for the removal of which the above remedy has been found effective.

During the war much more attention was paid to the manufacture of cider and perry than since its close. In fact, at the time alluded to, no inconsiderable quantity of cider was employed in adulterating various wines; and much of the better sorts of perry were sold as champagne. As much as 50*l.* per hogshead has been given for perry;—nothing like such a price has been paid for many years. It may, however, be doubted whether much that is imported from France, and consumed as genuine champagne in this country, is not greatly inferior to what can be made from our best pear and apple orchards, if due care were taken in its manufacture: in place of which, the Herefordshire farmer pays little attention to the quality of his cider, and little perry is made, excepting the variety called Barland, which will be noticed hereafter. This arises, in a great measure, because the consumption is almost entirely local, the ordinary allowance to labourers being at the rate of 2 to 3 quarts daily, to mowers 5 or 6 quarts, reapers and harvest-men as much as they can drink—the latter classes are said to average 12 quarts daily. Such being the ordinary consumers, the owners of orchards in Herefordshire very rarely pay that attention to the making of cider which the subject deserves: with the bulk of farmers, if the liquor when made has body enough to keep, it is all that is looked for; richness and flavour not being attended to. The absence of cheap means of communication with the great midland manufacturing towns, the metropolis, &c., has almost annihilated the market for Hereford cider other than such as is required for domestic consumption. The supply of cider to the great masses of urban population scattered throughout England is chiefly obtained from Devon and the Channel Islands; a traffic greatly aided by the cheapness and facilities which exist for its transit by sea, whilst the railway communication from Devon to the Birmingham district is cheap and expeditious. Notwithstanding the disadvantages just noticed, it is highly probable that, if proper attention were paid to the manufacture of perry and cider, a demand would spring up for these agreeable effervescent beverages greatly beyond what is ordinarily supposed; and in this instance it is indispensably necessary that supply should precede demand. To accomplish this end, a neither too dry cider (such as is made for

local consumption) nor a too sweet liquor should be made. A metropolitan palate, accustomed to the use of sweet cider, would consider the rough cider of the farm-house a mixture of vinegar and water. It is one of the evils attendant on the present somewhat careless mode of making dry cider that a considerable quantity of acetic acid, or vinegar, is formed, to the great detriment of the strength of the liquor; for every particle of vinegar produced is obtained at the expense of an equivalent amount of alcohol, or spirit. A well-made dry cider ought to be almost free from acid, devoid of sweetness, non-effervescent, with a flavour and taste not greatly dissimilar from Rhenish or Moselle wines. Perry, by careful management, can be made to resemble champagne, and of a quality decidedly superior to much that is sold under that title. Careful attention is requisite to accomplish these ends, such as can only be repaid by the construction of large establishments, superintended by persons skilled in the management of vinous liquors, or, at all events, versed in those sciences which are connected with the alterations caused through the effects of temperature, fermentation, &c.

That such establishments are likely to be founded is not at all probable; in order, however, to induce improvement, it is requisite to point out the *modus operandi*. As the county of Hereford contains a more than usual number of resident well-to-do proprietors, possessing orchards, it may happen that these observations may meet with attention from some party so circumstanced, who, by instituting a careful series of experiments, will find amusement and employment; the results of which will, no doubt, be not only remunerative, but also calculated to promote the public welfare, by enhancing the value of a species of agricultural property which has hitherto been much neglected, and has far from kept pace with the growing intelligence of the age. There can scarcely exist a doubt but, if perfectly well made dry cider and sound perry were manufactured on a large scale, a demand of a most extensive character would arise for them greatly beyond the limits to which their consumption is now confined.

Pears yield more juice than apples, and some species of apples more than others; 2 hogsheads of pears will yield 1 of expressed juice; but some sort of apples, as the "stere" and "Haglor crab," in very dry seasons will only yield 1 hogshead of juice to 3 of fruit. The adjoining county of Worcester is rather more celebrated for the manufacture of perry than Hereford; the latter, however, is justly celebrated for its Barland perry, produced, it is said, originally from fields in the parish of Bosbury, called Bar-lands or Ban-lands. A dry sharpness is the characteristic of the Barland perry, rather than the mellifluous richness which we identify with champagne. The usual fault in English

perry is a mawkish sweetness; this is owing to deficient fermentation, and might be remedied if that important process be properly attended to. The squash pear is usually esteemed the best pear for producing perry, and the stere apple certainly produces the strongest and probably the finest flavoured cider.

Pears and apples have been examined by Berard, without, however, having entered upon many interesting points, such as the rapid conversion of lignine, &c., into sugar when the fruit is allowed to remain to mature or ripen after being taken off the tree. The following are the results which he obtained from Beurré pears examined in three states, namely, 1, ripe and fresh; 2, kept until mellow; 3, kept till brown or beginning to rot, and having lost 23·15 per cent. of water, &c.:—

	1.	2.	3.
Resinous green colouring matter .	0·08	0·01	0·04
Sugar	6·45	11·52	8·77
Gum	3·17	2·07	2·62
Lignine	3·80	2·19	1·85
Albumine	0·08	0·21	0·23
Malic acid	0·11	0·08	0·61
Lime	0·03	0·04	trace
Water	86·28	83·88	62·72

Apples contain the same ingredients as pears, but in different proportions, the former usually containing more of the malic acid and less sugar, also more tannin than pears; the latter circumstance is the reason why perry is so much more liable to become ropy than cider: the remedy has been already indicated.

The above tables are exceedingly instructive in a practical point of view, as establishing the soundness of the system which permits the fruit to fully mellow before it is sent to the press, but not to allow it to proceed to decay; in which case not only will the flavour of the liquor be impaired, but a loss of saccharine matter will be incurred. Having now gone over the principal points connected with the manufacture of cider and perry, one subject has been reserved for the last, which, in a commercial point of view, can scarcely be over estimated. It is well known that pears and apples possess, not only different flavours, but also different varieties of the same species of fruit have aromas and flavours of a distinctive character. These have been usually overlooked in chemical analysis, as of too refined a character for the present state of that science. Yet it is, in a great measure, upon the production of these peculiar aromas and flavours to which we must look forward as the last step in improving the character of our home-made vinous liquors made from the apple and the pear, so that they may rival the productions of continental vineyards. It has been supposed by Liebig, that the superior aroma found to obtain amongst the

wines produced in the cooler vine-growing districts is owing to the greater proportion of tartaric acid existing in the grape, whilst in hot climates sugar preponderates. Whether the theory is correct or not, it may be worthy of an experiment, to see whether a few pounds of cream of tartar placed in a hogshead of apple-juice will give the resulting cider a superior aroma; and common commercial argols might be used; if so, it would be a great step gained, for, even without such assistance, good sound and carefully-prepared dry cider has fallen under our notice which could be favourably compared with many of the wines produced on the Rhine and the Moselle.

It has already been shown that undecayed pears contain adequate saccharine matters to make a liquor superior in strength to champagne; whilst the ropiness which sometimes occurs may be corrected by tannin, or perhaps, still better, by using along with the pear-juice a small quantity expressed from some of the more astringent kinds of apples, which sometimes contain a comparatively considerable amount of tannin. If the conditions laid down be carefully attended to, the manufacturer will arrive at all the principal features of champagne, viz., briskness, brightness, and strength; the aroma only being wanted to complete the parallel.

It has already been stated, that analytical chemistry has hitherto failed to separate in a distinct body those agreeable flavours which accompany, and are peculiar to, many ripened fruits. What analytical chemistry has failed to accomplish, synthetical chemistry has produced, or, at all events, sufficiently so for practical and commercial purposes. If the delicate perfumes manufactured of late years are not identical in their chemical composition with the natural ones which they are intended to represent, the olfactory nerves and gustatory organs fail to discover the difference between those artificially prepared and such as are formed by nature. We are indebted to the Great Exhibition, and the lecture subsequently delivered by Dr. Lyon Playfair, for an exposition of this subject: in that portion of his lecture which relates to perfumery it is observed—"The perfumes of flowers often consist of oils and ethers, which the chemist can compound artificially in his laboratory. Commercial enterprise has availed itself of this fact, and sent to the Exhibition, in the form of essences, perfumes thus prepared. Singularly enough, they are generally derived from substances of intensely disgusting odour. A peculiarly fœtid oil, termed 'fusel oil,' is formed in making brandy and whiskey. This fusel oil, distilled with sulphuric acid and acetate of potash, gives the OIL OF PEARS. The OIL OF APPLES is made from the same fusel oil by distillation with sulphuric acid and bichromate of potash." The acidulated drops sold by the confectioners and grocers, per-

porting to be flavoured with the essence of jargonelle pears, &c., have their peculiar aroma conferred upon them by the artificial substances manufactured as just described. The greatest and only difficulty, therefore, which remained as an obstacle to well-manufactured perry vieing with, if not outrivalling, champagne is thus removed.

To obtain such results it will be requisite for one or more intelligent individuals to direct, not only constant, but almost enthusiastic attention to the subject; for fermentation is so much affected by changes of temperature, that the slightest neglect will frequently occasion irreparable injury. Those who have witnessed the care with which this point is attended to in the large wine establishments on the Continent, where the climate is much more equable, will understand why this subject should require more careful watching in our more variable climate: an equable temperature, racking when necessary, and slow secondary fermentation, are the great secrets of success.

Breed of Cattle.—The Hereford, or, as they have sometimes been termed, the middle-horned cattle, have ever been esteemed a most valuable breed, and when housed from the inclemency of the weather probably put on more meat and fat in proportion to the food consumed than any other variety. They are not so hardy as the North Devon cattle, to which breed they possess a general resemblance: they, however, are much larger than the Devons, especially the male animals. On the other hand, the Herefords are larger boned, to compensate for which defect may be cast in the opposite scale the fact that the flesh of the Hereford ox is superior to all other indigenous breeds for that beautiful marbled appearance caused by the intermixture of fat and lean, which is so much prized by the epicure. All observant persons who have travelled through the county of Hereford, and the adjoining district of South Wales, as far as Pembroke and the opposite coast of North Devon, must have been struck with the general resemblance in outline of the breeds indigenous to those districts; indeed the comparison may be carried further, for the South Hams of South Devon and the Sussex cattle greatly resemble the Glamorgans in all but colour, the most esteemed breed of the last-mentioned being black. A mixed black brown, red and dun coloured race of cattle are found throughout all the southern Welsh counties, the whole greatly resembling in symmetrical appearance the true Hereford, varying only in colour. In the adjoining counties of Monmouth and Brecon the true Hereford almost invariably prevails. The Hereford is usually deeper in the chine, and the shoulders larger and coarser than the Devon. They are worse milkers than the Devon, or than, perhaps, any other breed, for the Hereford grazier has neglected the female,

and hitherto paid the whole of his attention to the male. This defect is likely to be gradually remedied, owing to the premiums given by the Royal Agricultural Society of England, and similar institutions offering rewards, that induce breeders to emulate each other in rearing superior female stock; for it cannot be doubted that, other things being equal, a well-proportioned roomy cow is better calculated to rear superior cattle, both male and female, than one of delicate character and indifferent form.

The old Herefords are said to have been brown, or reddish brown, and it is only within the last eighty or ninety years that it has been the fashion to breed for white faces. The history of the introduction of the latter we are assured arose as follows:—the gentleman who furnished the statement says that he was informed by Mr. P. Tully that the introduction of the white-marked cattle was accidental, and occurred in the stock of one of that gentleman's ancestors, who lived at Huntingdon, in Holmer, and in the following manner:—"That about the middle of the last century the cowman came to the house, announcing, as a remarkable fact, that the favourite cow had produced a white-faced bull calf. This had never been known to have occurred before; and, as a curiosity, it was agreed that the animal should be kept and reared as a future sire. Such, in a few words, is the origin of a fact that has since prevailed through the county, for the progeny of this very bull became celebrated for white faces."

The gentleman who kindly furnished this information states—"That it ought never to be forgotten that our county breed might have remained for years localised if it had not been for Mr. Westcar, who, from 1779 to 1819, never omitted visiting the Hereford October fair, and making purchases; and who induced the Duke of Bedford, the Duke of Manchester, Lord Talbot, and other noblemen, to adopt the same plan."

History relates that Robert Fitzhammon, the usurper of the Lordship of Glamorgan, in the reign of William Rufus, was also Lord of Asterville in Normandy, where a breed of red cattle is still found; also, that Sir Richard de Grenaville, one of the twelve knights who took possession of the Lordship of Neath in Glamorgan, was lord of the manor and castle of Bideford, on the northern coast of Devon. By either, or both these means, a red stock of cattle was probably introduced into Wales, and so into Hereford. The river Wye, which almost bisects the county, was appointed the boundary of the two counties by Athelstane in 939. The colours of the then prevailing cattle in Wales is indicated in the laws of Howell the Good, in which compensation for injuries done to the princes of Aber—Ffraw in North Wales and Dinevaur in South Wales—was fixed at 100 *white cows with*

red ears and a bull of the same colour for every *cantrev* in the possession of the transgressor; and if the cattle were of a dark or black colour, then 150 in number for every 100. The same number of cattle were to be presented by the Prince of Aber to the King of London when doing homage for the Principality. Speed records that Maud de Brehos, in order to appease King John, who was highly incensed against her husband, made a present to the Queen of 400 cows and one bull from Brecknockshire, all white with red ears. These facts are suggestive of the mode in which the white-faced cattle have originated.

Effect of Soil on the Growth of Timber Trees.—The orchards alone of central and eastern Herefordshire would confer on those parts of the county a sylvan aspect; to this has to be added the effect produced by innumerable clumps of trees and luxuriant hedge-row timber, combined with a larger number of small park-like inclosures than can be found in any other part of England of equal extent; these conjointly have the effect of giving to this county an eminently woodland character. So congenial is a large part of the soil of Herefordshire to the growth of timber-trees, especially oaks, that they (the oaks) have been called "the weeds of Herefordshire;" whilst coppices of ash, oak, and willow, occasionally intermixed with hornbeam, occupy much of the stiff clay soils on the silurian rocks around Woolhope, and adjacent to Ledbury, as well as near the margins of many of the upland streams. The steeper acclivities of the various rising grounds are generally thickly strewed with thriving timber or coppice. The demands for the navy during the war cleared the county of a very considerable amount of its timber; still sufficient is left not only for pictorial effect, but also for domestic utility. On the rich deep soils of the cornstones the oak shoots up with luxuriant magnificence; this rapid growth is, however, unfavourable to the development of that closeness of grain, and attendant "toughness," which is usually identified with the character of British oak. When cut up, these straight, rapid-growing oaks are found rather to resemble that which is imported from Canada, or the open texture usually found in bog oak. The deep, stiff, and somewhat impervious soils of the cornstones appear especially adapted to the growth of oak; whilst the ash affects more open and drier soils, such as friable loams formed by the intermixture of the more silicious substances derived from the débris of the upper series of quartzose rocks of the old red sandstone, with either fine alluvial matters, or the cornstone marls. Beech, elm, and birch thrive well on the calcareous grits and grey calcareous sandy beds on the upper silurian rocks at the north-western corner of the county.

There can be no doubt that, for the production of apples for

table use, the finest fruit and the largest returns will be made both in the relative and actual value of individual specimens of fruit grown on trees planted on a rich deep soil; it may, however, be doubted whether fruit so grown is the best calculated for making the finer kinds of cider; a free and open, but not over rich, sandy loam appears the best calculated for the latter purpose. In this, as well as many other respects, the pear has many advantages over the apple tree, being not only of a hardier character, but also from its capability of being cultivated successfully on a greater variety of soils, where, for the purposes of making perry, the juice is little if at all inferior to that produced from the same species on friable loams. The pear is more productive than the apple, and will flourish on a greater variety of soils, even to those of an inferior quality, on which apples would yield a juice little superior to that of the crab. As an ornamental tree, the pear is also deserving of attention. The pear-tree lives much longer than the apple, and will scarcely fail on any soil where it may be planted, provided it is not incommoded with water.

The Suitableness or otherwise of the Farm Buildings to Improved Husbandry.—Owing to the general size of farms in Herefordshire being above the average, the system of cotting sheep that existed at an early period, and the necessary shelter required for carrying on the manufacture of cider, the farm-houses in Herefordshire are not so deficient in out-buildings as those situate in many other districts in England. Whilst attention was paid principally to pastoral husbandry, the deficiency of shelter for young stock has been compensated in a great measure hitherto by employing the orchard that accompanied the farmstead as a fold-yard; that a considerable amount of warmth and shelter was thus secured, without any large permanent outlay, is certainly true, but a great waste of valuable manure was consequent on this plan, which, added to the inadequate shelter afforded, as compared with that yielded by properly-constructed out-buildings and fold-yards, renders further buildings necessary. It ought not also to be forgotten that the modern system of husbandry implies the growth of heavy root, and other green crops, as winter provender and forage, which, if not soiled on the fields where they are grown, have to be brought to the homestead for consumption; the labour connected with this would be further enhanced where it requires to be distributed on a place encumbered with trees; under such circumstances the economical consumption of the crops noticed, by the aid of turnip and chaff-cutters, is rendered almost impossible. Besides, it is now well ascertained that the most profitable mode of bringing young or store stock to market is, never to allow them to "stock," or be

impeded in their growth; this proper control the farmer cannot possibly possess unless in possession of sufficient roofed shelter. It would be difficult to say whether the rearing of store stock or fattening of cattle is the system best calculated to produce the largest amount of annual gain to the bulk of Herefordshire farmers. On considering all the circumstances of his position, a mixed system may probably prove the best. A very great number of oxen are fattened within the county, namely, on the heavy soils of the cornstones, the rich alluvial flats which occupy considerable areas on the banks of the Wye, and other local rivers; on some of the last-named places, the pasturage may almost compare for its feeding qualities with the celebrated Lincolnshire marshes, which stretch from Skegness to Wainfleet. The great capabilities of the general soils of Herefordshire for the cultivation of root and other green crops, and the consequent power conferred on the farmer to maintain a larger quantity of stock, either as stores or fattening cattle, during the winter season than in summer, has caused the present out-buildings of the farmsteads in this county to fall short of the requirements needed by the altered system of husbandry which is so rapidly taking place on all light soils, such as those which constitute the major part of the surface of Herefordshire. Some further remarks will be made relative to this subject in a subsequent section.

The extent of Draining effected in the County.—The amount of draining executed in Herefordshire is by no means so extensive as might be desirable, seeing the benefits which it would confer. Several reasons concur to prevent the rapid extension of drainage, amongst which may be mentioned the great extent of orchards and timber which not unfrequently will be found to present impediments: on some of the lands which would be most benefited by drainage no outfall exists; this latter remark applies particularly to the alluvial flats already noticed. Whilst naming this, it will be well to draw attention to the fact, that if drainage be carried on to any serious extent in Herefordshire, the flat alluvial lands on the banks of the rivers and streams will be subjected to inundation on every recurrence of a heavy fall of rain, unless precautions are previously taken to afford greater facilities for the passage of the water along its present courses, by the withdrawal of weirs and other impediments to its progress; under existing and ordinary circumstances these rich meadows are almost annually overflowed, and it is only necessary to draw attention to the extensive inundations which have taken place during the two years just past as a full illustration of the subject. If, therefore, so much damage and inconvenience have been incurred under the existing state of things, how much more serious may the injury become unless proper precautions are taken

to ensure a rapid outlet for the waters which would be poured into the streams in so much more powerful volumes, if thorough draining were extensively carried forward. Much of the heavy soils on the corn-stones would be greatly improved by drainage. On the loose soils drainage is scarcely thought of. Owing to the great amount of trees growing in Herefordshire, few counties would derive a greater benefit by the amelioration of climate which would be effected in carrying out a thorough system of drainage than Herefordshire.

Improvements made since the Report of J. Duncombe in 1805, *and to what extent still required.*—It scarcely admits of doubt that the manufacture of cider and perry has retrograded in this county since Mr. Duncombe's Report appeared, but in all other respects the agriculture of Hereford has improved. To understand the matter better, it will be as well to briefly transcribe a few remarks from Mr. Duncombe's work, under the head of tillage, in which he proceeds to state that "Wheat is the grand dependence of the farmer, who is situated on the stiff clays * with which this county abounds; but it is conceived that the following course, which formed the old routine of crops on that description of land, is liable, with this management, to serious objections. A good fallow, on a clover-ley, well worked, limed, and manured, produces on an average about 20 bushels of wheat per statute acre. In the following spring it is sown with peas, sometimes beans, after one ploughing, and without manure; the produce is from 12 to 14 bushels per acre. After two ploughings and a partial dressing, or much more frequently with no dressing whatever, it is again sown with wheat in October; and if this *brush* crop, as it is termed, produces somewhat more than half the quantity yielded by the fallow crop the grower is satisfied. In the following spring it is sown with barley and clover seeds after two ploughings, but still without manure, and as may be expected from the exhausted state of the land, it generally affords a very inconsiderable crop."

"Sheep are turned on the young clover as soon as the barley is removed. Sometimes oats or turnips precede the barley on a small part of the land, and a few winter vetches are occasionally introduced, but still without manure or any preparation other than one or two ploughings.

"After mowing one crop of clover it is fed with cattle the following spring, and afterwards a part remains for seed. The fallowing then recommences, and nearly the same system is repeated. In this manner nearly one-third of the arable land is

* It has already been noticed that the so-called clays do not contain much aluminous matter.

constantly under the culture of wheat, and that third, during its preparation for the seed, is termed the *odd mark.*"

Mr. Duncombe further observes, "It will not be supposed that the routine above described is still invariably adhered to, it is given merely as the old-fashioned course, from which many farmers are deviating daily with success."

It will be evident to any one acquainted with modern farming, that there existed abundant room for improvement; the farmer that would till his land for a produce of 12 to 14 bushels per acre of peas or beans on a stiff but otherwise favourable soil, would be considered in the year 1853 a fit inmate for a lunatic asylum; which if he escaped by any chance, it is quite certain that he would find his way to the workhouse. The use of green crops in the fold-yard has greatly increased since the commencement of the present century, as well as their cultivation for soiling with sheep; barley, clover, and wheat following in rotation; in this way a full average of 24 bushels of wheat is secured per acre, followed by excellent crops of barley and clover, the soil in Herefordshire being, generally speaking, exceedingly well adapted for the barley crop. Arable husbandry would not only increase but improve most rapidly in Herefordshire, if only a sufficiency of manures could be obtained. The Herefordshire farmer has few resources for manure beyond that which can be supplied on his own farm; for bones are scarce and expensive, whilst though superphosphates, guano, &c., when procured genuine, have proved abundantly productive, the cost and expenses of carriage, but still more the fraudulent adulterations, have caused them to be less used than they otherwise would be. The Herefordshire farmers would consume artificial fertilisers to a much greater extent than they now do if they could be supplied at a reasonable rate and secured from fraud; it is not, therefore, from a want of knowledge or due appreciation of their utility, that they are now so sparingly used, but owing to the causes assigned they are comparatively neglected.

The great demand that exists for Hereford cattle for supplying the graziers of the midland counties with store stock, has a tendency to make breeding the most prominent feature of Herefordshire farming; if, however, an adequate supply of good portable fertilisers could be procured, it would enable the farmer to keep a large amount of store-stock over until the spring, and thus secure a fair amount of farmyard manure. Under present circumstances it is generally found most economical to feed off turnips with sheep in the mode already indicated.

The system of soiling turnips with sheep, combined with the difference in the values of British fine wool at the present period, as compared with those which ruled at the commencement of the

present century, has caused a complete change in the species of sheep which are now bred by Herefordshire flock owners. At the former period, a small breed indigenous to this and the neighbouring old red sandstone districts, was the usual one; they were small and hardy with a fine fleece, the choicest specimens were known as ryelands, and it is only in the vicinity of Ross that the true breed are now to be found; they are very like the Spanish merino, especially the ewe. They are small, white-faced, and hornless; they lamb in February or March, and are sometimes "cotted," when pease-haulm is generally given to them. The practice of "cotting," or housing sheep in places erected for the purpose, is said to have been derived from the Flemings, and introduced into England about the year 1660.* The weight of wool only averaged about 2 lbs. per fleece, but in quality it has always been estimated as equal to merino. A cross between the southdown, ryeland, and German merino, would probably prove a most valuable animal, as supplying fine wool with sufficient carcase and rapid feeding properties; it is in the latter quality that the old ryeland sheep fails in comparison with the new Leicester and improved South Down. The Ryelands were originally crossed with the early improved Leicesters, from which cross has descended a large part of the mongrel animals which are now found in the county. Of late years the Southdowns have been taken into favour, but there is reason for believing that a cross from the Southdown with the true Ryeland, would produce an animal best adapted for the soil and climate of the district, and the Ryeland is the quickest feeder among our original breeds.

Drainage and a plentiful supply of sound artificial manures, appear to be the great desiderata required in this county in order to make it rank on an equality with any other agricultural district in England.

XXXI.—*Report on the Exhibition of Live Stock at the Gloucester Meeting of the Society.* By Richard Milward.

The Stewards of Cattle, in making their Report, regret that they are unable to congratulate the Society with regard to the Exhibition of Live Stock. The show was unquestionably below the average of former years.

The stewards have found some difficulty in framing their Report, in consequence of the new system respecting the examination of animals by jury; but the fact must be stated, whether palatable or not, that the lower character of the show

* Systema Agriculturæ, folio. London, 1668.

was mainly attributable to the above regulation; it being well known that many of our first breeders refused to exhibit, not choosing to run the risk of their animals being disqualified for over fatness.

Another rule of the Society, which has only been in operation at Lewes and Gloucester, viz., limiting the age of bulls to four years, has also had a material effect in reducing the number of good animals; and the Council must now decide whether they will continue these restrictions, or allow animals of all ages to be shown, without a jury of disqualification, leaving it to the judges to award prizes to those which are most likely to be of service to the country.

It perhaps ought to be stated how the jury system was carried out at Gloucester. The animals were arranged in three classes, and a jury of nine judges in each class, drawn by lot, proceeded to examine every animal previous to commencing their inspection as judges. No cattle or horses were rejected as unfit to compete, some of the judges stating, that had their animals been excluded they would have ceased to exhibit.

Only two sheep and two pigs were disqualified.

The whole of the stock was examined by Professor Simonds, to guard against any infectious disease, as well as to acquaint the judges if he discovered any hereditary unsoundness in animals to which they awarded prizes.

In the short-horn classes some good animals were exhibited, but many not possessing much merit; and the judges "*think that the recent regulation as to examination by jury has tended to lessen the number of good animals shown.*"

The Herefords were generally good, but the judges were disappointed in the number shown, and particularly when the meeting was held in their immediate locality.

The Devons kept up their reputation: the heifers were particularly good; but although the total number of this breed far exceeded those shown at Lewes, yet there were fewer bulls than the Society had a right to expect. The judges were of opinion that the new regulation had not interfered with the show in this section of cattle.

The Welsh breed was a complete failure: 70*l.* was offered by the Society, for which only five animals were shown, and these were not worth the amount of the prizes. With regard to Other breeds the same remarks would nearly apply: 40*l.* was offered in six prizes, and only 12 animals shown. We may now hope that after repeated trials, with the best intentions to draw out the cattle peculiar to a district, the Society will cease to offer prizes for any but the three recognised breeds of cattle.

The Leicester rams were not thought equal to former years,

and there were only four pens of ewes; nevertheless, Mr. Sanday and Mr. Paulett exhibited several fine animals, and between them carried off all the prizes.

The Long Wools were particularly good, their quality having very much improved: the two pens of Theaves shown by Mr. Lane were worthy of the great admiration they received.

The Southdowns, as usual, were very good: their uniform character and symmetry elicited general encomiums.

The new class of Shropshire Downs was very successful: it is to be hoped that the Society will recognise them as a distinct breed.

The show of Pigs was excellent: where there were so many good it is difficult to particularize, but the boar belonging to Mr. Crossley was a fine active and useful animal; and although in high condition, was not too fat for use. It perhaps ought here to be stated, that the sow belonging to Mr. Northey, which was disqualified for over fatness, has since produced eight young ones.

With regard to Horses, although many were exhibited, it cannot be stated that the show was a good one. There were, it is true, several fine specimens of the Suffolk breed, but the judges expressed great dissatisfaction at the ordinary show of roadster stallions; and the exhibition of Welsh ponies will not, it is thought, induce the Society to offer similar prizes in future.

The Poultry show was considered very good. Great competition in nearly all the classes; and although the weather was not favourable, they appeared to attract a full share of attention.

In the Report of the Lewes Show a tabular account was given, embracing all the meetings of the Society. It is not thought necessary to reprint those tables, but merely to state the numbers in each class shown at Gloucester, compared with those at Lewes.

Comparative Summary of the Lewes and Gloucester Meetings.

	Short Horns.	Herefords.	Devons.	Sussex.	Welsh or other Breeds.	Leicester.	Long Wool.	South Down.	Shropshire.	Other Sheep.	Agricultural Horses.	Other Horses.	Pigs.	Poultry.
Lewes . .	64	29	38	75	17	90	27	158	..	57	80	7	186	226
Gloucester .	75	43	55	..	17	80	144	139	121	..	69	28	177	912

The stewards have some suggestions to make with reference to the next show of Stock, but probably this will not be considered the proper place.

Thurgarton Priory, November 17, 1853.

XXXII.—*Agricultural Chemistry.—Pig Feeding.* By J. B. Lawes, of Rothamsted.

In a former Number of this Journal we published a paper under the title of '*Sheep Feeding and Manure*,' in which we gave the amount of *Increase in Live weight of Animal*, obtained by the consumption of known quantities of food of various kinds—the chemical composition of such food being also given—and we promised to follow up the subject in our next with an account, first, *of the Composition of the Increase in Live weight*, and afterwards, *of that of the Manure obtained.* The main object, indeed, of the investigation—as stated both at the commencement and conclusion of that paper—was, to illustrate the general economy of the feeding process, *as one of the great features of farming practice;* that is to say, as producing *Manure* as well as Meat, rather than as comparing one food with another in regard to its *feeding* value merely.

Sheep had at that time received the greatest share of our attention; and, owing to the difficulty and labour involved in extending the field of experiment in like detail to other animals, it was intended, if possible, to complete our subject of *Meat* and *Manure-making* by almost exclusive reference to the animals which had given the title to our paper. The further we progressed, however, the more were we convinced, that in spite of the difficulties and necessary postponement of publication, the inquiry must be extended to other animals, to enable us at all satisfactorily to explain the connection between the composition of the food consumed by farm stock generally, and that of the increase, and manure, obtained.

Viewing the feeding process as one of the chief means of obtaining *manure*, it is of the utmost importance that the farmer should be possessed of some principles by which to judge of the productive power of such manure, especially in relation to the composition and value of the food consumed. And, as in this country there is employed a constantly increasing amount both of purchased and saleable food, and of artificial manures, it is essential that the farmer should possess a clearer conception of the principles both of *Feeding* and of *Manuring.*

The importance of such general propositions in agriculture cannot be over-estimated; nor will they be undervalued when farmers more clearly recognise and appreciate the influence of chemical composition in determining the value of manure, and how far it is a question merely of *economy*, whether the fertility of the soil shall be kept up by manures produced in the yard and the stall, or by those which are purchased in the market.

We do not mean to say that it is unimportant in what state, or in what manner, a manure is supplied, but in illustration of the general truth which we would have kept in view, we may here call attention to the fact which we have frequently noticed, namely, that a crop of wheat, of more than the average yield of the neighbourhood under the ordinary course of cultivation, has for several successive years been grown in the same field on this farm, by the supply of *pure chemical salts* alone. Let it, then, we repeat, be clearly understood, that, in a certain point of view, it is a matter of indifference whether we purchase food for cattle, or direct manures—and that in some respects therefore the two classes of manures can to a great extent mutually replace each other.

Let this be a settled idea in the farmer's mind, and he will more clearly see the importance of a better understanding of the feeding process, and also of those circumstances which must determine the *economy* of the mutual substitution of artificial manures and those derived from the fatting animal.

In prosecuting our inquiries into the general laws of *Meat and Manure-making*, we have found it necessary to extend our experiments from Sheep, as at first undertaken, to Oxen and Pigs.

Our results, in relation to both these descriptions of animals, as well as the sheep, will eventually be considered in reference to *Manure* as well as *Increase;* but we think it desirable to bring forward the whole of the *feeding* experiments, before entering upon those relating to manure. In pursuance of this plan, a portion of the present paper on *Pig feeding* was actually in type nearly three years ago, when that subject was somewhat prominently before the agricultural public; but, owing to other engagements, its completion has necessarily been delayed until the present time.

The necessity of including Pigs in an inquiry relating to the production of meat and manure on the farm, is further seen when we come to consider the character of the food supplied to them. Compared with that of sheep or bullocks, its dry substance consists, weight for weight, of much more highly nutritive vegetable products, and it is consequently generally much more costly to purchase. Thus, whilst the food of *fatting* sheep or oxen, is principally composed of grass, hay, and roots, with a comparatively small proportion of cake or corn, that of the pig, whose digestive apparatus is very differently constituted, is almost exclusively corn, or contains scarcely any indigestible woody-fibre, and abounds more largely in starch, fatty matters, and nitrogenous compounds. We should expect, then, a very different rate of increase in relation to gross weight of dry food consumed in the two cases; whilst in the excrements

of the pig we should hope for a manure commensurate with the cost and richness of the food which has been its source.

Setting aside what may be termed the incidental food of the pig, such as wash, potatoes, and other roots, it may be said that his staple *fatting* foods in England are the *leguminous seeds*, such as beans, peas, tares, and lentils, all of which are characterised by containing a high per-centage of nitrogenous compounds; and, in still larger quantity, some of the *grains*—especially *barley*—the inferior qualities of which are almost exclusively devoted to his use.

The *grains*, as compared with the leguminous seeds, contain scarcely half the quantity of nitrogenous compounds, upon which so materially depends the quality of the manure; but they abound much more in starch and other *non*-nitrogenous compounds, which are believed to provide the chief of the respiratory and fat-forming food of the animal. The quantity of actual *fatty-matter* in the two classes of foods is variable; but it is on an average rather greater in the grains than in the leguminous seeds.

Pollard and *bran* are also much used as pig-foods. They contain a large amount of woody fibre; but the bran more especially contains a much higher per-centage both of *nitrogen* and of *fatty-matter* than the entire grain from which it has been derived.

Of the several articles of food enumerated above, *barley* is undoubtedly most in favour as the fatting food of the pig; but as *nitrogen* is so important a constituent in *manure*, and as barley, as we have said, contains scarcely half so much of this substance as the leguminous seeds, it is evidently a matter of importance to consider, whether the latter might not advantageously be employed more largely than at present—even supposing that *barley* had some slight superiority, so far as the animal alone was concerned.

That the profit of feeding, indeed, is to be sought *within* the limits of the value of the manure, and that it is, therefore, much dependent on the quality of the latter, and, consequently, on the judgment exercised in the selection of the foods, and the management of the animals and of the manure—is a view which seems to be supported at once by the convergent testimony of current experience and by a consideration of the laws which regulate the price of all articles in general use. Admitting that the prices of all such articles are regulated by the *cost of production*, and that they cannot long either be produced at a loss, or be sold at a price which will yield more than a fair profit upon the capital and labour employed in their production—and, applying this view to the subject before us, we should certainly decide, that the

selling price of the meat *alone* produced upon the farm must be less than that of the food consumed—and that the profit of the feeding process is to be found in the remaining product, namely, in those parts of the food which are rejected by the animal, and which, under the title of *Manure*, give fresh fertility to the soil, and thus supply a *second product* for the market.

Were it true, indeed, that as a rule the difference between the purchasing and selling price of the fatting animal was equal to, or more, than the cost of his food, it is evident that the profit of the feeding process would cease to depend, as at present supposed, only upon the *united* value of meat and manure—and the latter might then be obtained, in any quantity, *free of expense!* On such a supposition as this, the economical employment of imported and artificial manures would, of course, be at an end; and, unless the rule applied equally to the consumption of the expensive green crops, as to purchased and saleable food, it might even be a question whether the principles of rotation were not entirely fallacious, and its practice ruinous!

Much as we anticipate that careful scientific investigation will conduce to the improvement of our national agriculture, we are far from expecting any important revolution in the main principles involved in the current practice of the best farmers. On the other hand, it is our firm conviction, that it is to a more thorough and generally diffused understanding of those principles—such as shall ensure the more complete fulfilment, in the daily practices of the farm, of the ends they are calculated to attain—that we must look for any such improvement. Far be it from us to assert that the mutual relationship between breeding, feeding, manuring, and the growth of green crops and of corn, as already fixed by experience, will always remain as at present. That this relationship will be subject to fluctuation, or even to modifications of a more permanent kind—as the result, as well of the progress of knowledge as of causes of a commercial character—we do not doubt; but we would have it more generally understood, that the most legitimate and useful province of agricultural chemistry, at least for the present, is to investigate and explain the recognised practices of the day, and thereby provide such data for the guidance of the intelligent farmer as shall enable him more fully and economically to carry out the principles therein involved.

In the arrangement of our experiments on the feeding of *Pigs*, it was our object to ascertain, not only the amount of increase obtainable from a given quantity of certain approved foods, but to determine the most advantageous proportion of the highly nitrogenous foods to those which are less so; and within what limits this proportion may be varied with a view to the quality of the manure, and at the same time consistently with the profit-

able progress of the animal. With this view the selection of the foods in the *First Series* of experiments was considered less in reference to their cost than to their composition, it being desired to provide such as contrasted strongly with each other in this respect. It was thought that greater definiteness of result would thus be attained; and that the principle once elicited by this means, the more economical substitutes for the foods employed, could afterwards be easily pointed out. Thus :—

As the *highly nitrogenous* food—a mixture of equal weights of *Beans* and *Lentils*, was employed.
As the comparatively *non*-nitrogenous food—*Indian corn meal.*
As providing a large amount of inert woody fibre—a constituent apparently so essential in the food of the ruminant—*Bran.*

Before entering upon the detail of the experiments it may be remarked, that it was not the object of them to compare one breed of pigs with another; nor are they calculated to determine the several practical points—such as the most profitable age for rapid fatting, &c.; so that, after giving a full account of the circumstances of our own experiments, we must leave it to the intelligent reader to decide how far the results obtained by us are to be reached, or improved upon, under the perhaps different circumstances of his own practice.

In the selection of animals, it was only sought to get such as resembled one another in character, age, and weight, in the several pens; and, with this view, a competent person was employed to go to the various styes and markets in the neighbourhood to purchase animals suited to our object.

It would have been quite impossible to collect, and accurately weigh and sample for analysis, the excrements throughout the whole of so extensive a set of experiments as that we are about to describe; and it was determined, therefore, to devote a few animals separately to the subject of *manure* as well as increase. These were placed upon rafters, which allowed the excrements to pass through upon a sheet of zinc below, and to be collected for analysis as described in our paper on "Sheep-feeding." In the other cases the animals were kept well littered with straw, in pens 7 feet by 8 feet, which were fitted up for the purpose in a spacious barn. The food was, of course, in all cases accurately weighed; and the animals themselves were put into the scales every fourteen days.

Experiments with Pigs—Series I.

For this Series, which comprised 12 pens of 3 pigs each, 40 animals were purchased, as nearly as possible of the same cha-

racter, and all supposed to be about 9 or 10 months old. They were bought in three separate lots, of 6, 20, and 14 respectively, between January 22nd and February 2nd, 1850. On the latter day they were all weighed, marked, and allotted, 3 to each of the 12 pens, in such manner as to get as nearly as possible the same weight in each pen. As will be supposed, this distribution by *weights* alone, did not secure animals of sufficiently equal feeding quality in the several pens. On the following day, therefore, they were changed from pen to pen, so as to provide as much as possible a similarity in this respect between pen and pen, and at the same time to retain a near equality in weight also. This being done, the weights stood as follows:—

Table I.

(Experiments with Pigs.—Series I)

Showing the Weights of the Pigs (in Pounds), when allotted to the Pens, February 3, 1850.

Nos. of the Pigs.	Pen 1	Pen 2	Pen 3	Pen 4	Pen 5	Pen 6	Pen 7	Pen 8	Pen 9	Pen 10	Pen 11	Pen 12
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	146	146	142	142	140	133	133	132	130	129	131	130
2	121	122	115	123	123	123	124	133	124	128	128	115
3	112	112	113	113	115	122	121	117	119	120	120	129
Total weights of 3 pigs	379	380	370	378	378	378	378	382	373	377	379	374

The allotment thus completed, the whole were supplied with as much as they chose to eat, of a mixture of one part bean-meal, one part lentil-meal, two parts Indian-corn meal, and four parts bran, these being the articles fixed upon for the subsequent experiment. Upon this mixture all were kept for 12 days, prior to commencing with the exact experiment, in order that they might become accustomed to their new situation, and reconciled to their new companions: for, in the allotment the various purchases had necessarily been intermixed, in some cases greatly to the disapprobation and discomfort of the individuals of those purchases. For a time constant quarrels ensued, and the molested animals frequently jumped from pen to pen, until they fell in with their former associates. Indeed, at first, it was no uncommon occurrence, after they had been left for some time, to find some pens almost deserted and others crowded. The use of the whip was found to be very efficacious in settling these disputes, and at length, all seeming to live amicably together, the exact experiment was commenced on February 14th, twelve days after the first allotment.

As would be expected, the increase during this preliminary period was far from uniform—those pigs having flourished most which had fallen in for the lion's share, whilst the weaker ones, which had been obliged to sulk in the rear until their more powerful companion had indulged to the full, clearly indicated their misfortunes by their weights. After that time, however, very little irregularity occurred from this cause, vigilant care being taken that each animal should have his share of food; and it soon happened, that the mere approach of the whip was sufficient to awe the pugnacious delinquent into humble retreat, while his weaker neighbour, in his turn, took precedence at the trough. These ill-tempers, though at first very troublesome, give way surprisingly by a little perseverance; and the evil of them, in a course of comparative experiments, is, after all, much less than in submitting to a faulty allotment.

The results of the second weighings, when the exact experiment was commenced, namely, on February 14th, are given below:—

TABLE II.

(EXPERIMENTS WITH PIGS.—SERIES I)

Showing the Weight (in Pounds) gained during the twelve days of the preliminary period; and also the actual Weights at the commencement of the exact Experiment on February 14, 1850.

Nos. of the Pigs.	Pen 1		Pen 2		Pen 3		Pen 4		Pen 5		Pen 6	
	Gain in 12 Days.	Weight Feb. 14.	Gain in 12 Days.	Weight Feb. 14.	Gain in 12 Days.	Weight Feb. 14.	Gain in 12 Days	Weight Feb. 14.	Gain in 12 Days.	Weight Feb. 14.	Gain in 12 Days.	Weight Feb. 14.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	30	176	11	157	21	163	31	173	28	168	24	157
2	14	135	20	142	16	131	8	131	5	128	21	144
3	17	129	11	123	15	128	10	123	20	135	22	144
Totals	61	440	42	422	52	422	49	427	53	431	67	445

Nos. of the Pigs.	Pen 7		Pen 8		Pen 9		Pen 10		Pen 11		Pen 12	
1	15	148	13	145	26	156	20	149	6	137	19	149
2	2	126	11	144	18	142	10	138	22	150	15	130
3	20	141	26	143	11	130	9	129	16	136	21	150
Totals	37	415	50	432	55	428	39	416	44	423	55	429

A glance at this table, by the side of the former one, will show that the gross weight in each pen was not nearly so uniform at the second weighing as at the first. This irregularity is indeed

undesirable; but is perhaps as small as we can hope for in any extensive experiments in which we have to deal with the subtle principle of animal life.

We have already stated that the articles of food selected for the First Series of experiments were—

1. A mixture of equal parts of Bean and Lentil meal, this being taken as the highly nitrogenous food.

2. Indian corn-meal, as containing, compared with the former, only a small quantity of nitrogen, but a comparatively large amount of the non-nitrogenous substances of the starch series, and also more of fatty matter. It is these various non-nitrogenous substances that are supposed more peculiarly to serve for the respiratory process, and for the formation of fat in the animal body.

3. Bran—characterised as containing a considerable amount of inert woody fibre and mineral matter, and comparatively but little of starch, sugar, and the like; it is not, however, deficient either in nitrogenous or fatty matters, being in these respects intermediate between the other two descriptions of food.

From these three standard food-stuffs, twelve dietaries were arranged, as follows:—

Pen 1. Bean and Lentil mixture, ad libitum.

Pen 2. 2 lbs. per pig per day of Indian-corn meal; and Bean and Lentil mixture, ad libitum.

Pen 3. 2 lbs. of Bran per pig per day; and Bean and Lentil mixture, ad libitum.

Pen 4. 2 lbs. of Indian-corn meal, and 2 lbs. of Bran per pig per day; and Bean and Lentil mixture, ad libitum.

Pen 5. Indian-corn meal, ad libitum.

Pen 6. 2 lbs. of Bean and Lentil mixture per pig per day; and Indian-corn meal, ad libitum.

Pen 7. 2 lbs. Bran per pig per day; and Indian-corn meal, ad libitum.

Pen 8. 2 lbs. Bean and Lentil mixture, and 2 lbs. of Bran per pig per day; and Indian-corn meal, ad libitum.

Pen 9. 2 lbs.* of Bean and Lentil mixture per pig per day; and Bran, ad libitum.

Pen 10. 2 lbs.* of Indian-corn meal per pig per day; Bran, ad libitum.

Pen 11. 2 lbs. Bean and Lentil mixture, and 2 lbs. Indian-corn meal per pig per day; Bran, ad libitum.

Pen 12. Bean and Lentil mixture, Indian-corn meal, and Bran, each separately, and ad libitum.

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* Increased to 3 lbs. after the first period of 14 days.

It will be seen, that by the arrangement of allowing a fixed and limited amount of one description of food, and another description to be taken ad libitum, a great variety in the proportions of the different classes of constituents is attained. And it will be readily understood, that—as in every case the animals were permitted to fix for themselves the limit of their consumption according to their natural wants and inclinations—and as the amount and composition of the food consumed was in each case known—the results obtained, would afford us the means of deciding, whether or not this limit of consumption, had been fixed by any common demand for either class of constituents which the food supplied.

But to explain the plan a little further. In the first 4 pens the highly nitrogenous *Bean and Lentil mixture* is given ad libitum; in Pen 1, without any other food; in Pen 2, with a limited quantity of Indian-corn meal; in Pen 3, with a limited amount of Bran; and in Pen 4, with a limited quantity both of Indian-corn meal and of Bran.

In Pens 5, 6, 7, and 8, the comparatively deficiently nitrogenous, but more highly starchy and fatty food, *Indian-corn meal* is given ad libitum; in Pen 5 alone; in Pen 6, with a limited amount of the Bean and Lentil mixture; in Pen 7, with a limited amount of Bran; and in Pen 8, with a limited amount both of the Bean and Lentil mixture and of Bran.

In Pens 9, 10, 11, and 12, *Bran* is the food given ad libitum, but in no case alone; thus, in Pen 9, it is with a limited quantity of the Bean and Lentil mixture; in Pen 10, with a limited amount of Indian-corn meal; in Pen 11, with a limited amount both of the Bean and Lentil mixture and of Indian-corn meal; and in Pen 12, with both the Bean and Lentil mixture and the Indian-corn meal, but, as before said, neither in this case given in limited quantity, each of the three descriptions of food being put into a separate trough, and the pigs allowed to take of either or all at their discretion.

In all cases the animals were fed three times a-day; namely, early in the morning, at noon, and about 5 o'clock. The limited food, if any, was mixed with a small quantity of that which was given ad libitum in the first two feeds of the day. Great care was taken in the management of the supply of food, both that the troughs should generally be cleared out before fresh food was put into them, and that the pigs should always have a liberal supply within their reach; and this, with a little attention and practice, was easily attained.

The pigs themselves were each weighed fortnightly; and the exact experiment extended over four such periods; namely, 8

weeks in all; at the termination of the feeding experiment all were killed; and the weights of the carcass, and of the total offal—and indeed of all the separate parts of it—were taken in each case. The slaughtering results will however not be given in the present paper; but will be reserved until we treat of the general question of the '*Composition of Animal Bodies.*'

In Table III., which follows, are given the particulars of the increase in weight, &c., of this First Series of Pigs.

TABLE III.

(EXPERIMENTS WITH PIGS.—SERIES I)

Showing the *Gain in Weight* (in lbs.) upon each of the 12 different Dietaries, of *each Pig*, and of each *Pen of Three Pigs*, during each period of 14 Days, and during the entire experimental period of 8 Weeks.

Nos. of Pigs.	Pen 1 Beans and Lentils (equal parts) Ad Libitum.					Pen 2 2 lbs. Indian Meal per Pig per Day; Beans and Lentils (equal parts) Ad Libitum.				
	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.
1	27	32	22	22	103	37	35	32	32	136
2	26	24	24	20	94	28	33	23	11	95
3	24	27	26	29	106	31	26	29	19	105
3 pigs	77	83	72	71	303	96	94	84	62	336

	Pen 3 2 lbs. Bran per Pig per Day; Beans and Lentils (equal parts) Ad Libitum.					Pen 4 2 lbs. Indian Meal, 2 lbs. Bran, per Pig per Day; Beans and Lentils (equal parts) Ad Libitum.				
1	29	15	16	16	76	37	29	26	33	125
2	26	16	3	7	52	14	18	19	16	67
3	28	29	3	12	72	18	6	13	23	60
3 pigs	83	60	22	35	200	69	53	58	72	252

	Pen 5 Indian Meal Ad Libitum.					Pen 6 2 lbs. Beans and Lentils per Pig per Day; Indian Meal Ad Libitum.				
1	31	6	40	19	96	29	26	25	26	106
2	15	13	13	13	54	32	22	16	16	86
3	12	17	19	23	71	30	28	18	30	106
3 pigs	58	36	72	55	221	91	76	59	72	298

TABLE III.—*continued.*

	Pen 7 2 lbs. Bran per Pig per Day ; Indian Meal Ad Libitum.					Pen 8 2 lbs. Beans and Lentils, and 2 lbs. Bran per Pig per Day ; Indian Meal Ad Libitum.				
1	18	33	29	21	101	41	38	29	34	142
2	15	18	17	15	65	30	22	18	29	99
3	33	37	37	36	143	34	27	20	25	106
3 pigs	66	88	83	72	309	105	87	67	88	347

	Pen 9 2 lbs.* Beans and Lentils (equal parts) per Pig per Day ; Bran Ad Libitum.					Pen 10 2 lbs.* Indian Meal per Pig per Day ; Bran Ad Libitum.				
1	7	12	12	18	49	−8	13	12	10	27
2	2	2	0	2	6	10	16	8	10	44
3	0	16	17	12	45	3	12	15	13	43
3 pigs	9	30	29	32	100	5	41	35	33	114

	Pen 11 2 lbs. Beans and Lentils, 2 lbs. Indian Meal, per Pig per Day ; Bran Ad Libitum.					Pen 12 Bran, Beans and Lentils, and Indian Meal, each Ad Libitum.				
1	17	14	15	14	60	35	33	29	17	114
2	24	11	5	8	48	24	3	1	17	45
3	15	14	19	22	70	36	29	12	18	95
3 pigs	56	39	39	44	178	95	65	42	52	254

In this Table we have the particulars of the progress of each pig, and it is therefore deserving of some few remarks; though, the effects of the different foods must be estimated rather by the gross result of the pen of 3 pigs than by the progress of any single animal. Casting the eye over the figures showing the increase in weight of different animals in the same pen, with one and the same description of food, it is at once seen, that all have not progressed alike under these supposed similar circumstances. Some of the apparent discrepancies were easily accounted for by some *incidental* circumstance in the character or health of the animal; and in such cases the strictness of the result of the entire pen is, of course, in some degree interfered with. It is therefore necessary not to overlook these particulars in judging of the effects of any particular food.

In the majority of cases, however, we believe that the differ-

* Increased to 3 lbs. after the first Period.

ences in the progress of the pigs allotted together in the same pen and with the same food, arise from general differences of constitution; and if the irregularity in this respect were equal in every pen, it would certainly be an advantage, for our object is not to show the extraordinary increase of picked animals, but the probable average result obtainable from pigs which have been bred or selected for fattening with ordinary care and judgment. Indeed, as already observed, our chief object in the allotment was to get a variation of quality within each pen with similarity between pen and pen in this respect; and the observations which were made at the end of the experiment, when the pigs were killed, clearly showed, that whilst on the same food, some had increased considerably in frame as well as flesh and fat, others had apparently accumulated fat almost exclusively. These variations of result, then, we attribute chiefly to the different constitutional tendencies of the animals. But, at the same time, though very great care was taken to prevent it, we do not pretend to say, that where the limited food was very decidedly of better quality than the remainder, the stronger animals did not sometimes obtain an advantage over the weaker ones. Perhaps in one or two instances, therefore, one pig in a pen may have done better, and another worse, than would have resulted from a due share of the allotted food. Supposing this to have been the case, however, it is still by no means certain that the results indicated by the whole pen are on this ground unfair as regards the effects of the total food supplied to it; for, although one pig may have increased much more than another upon a *supposed* equal diet, the gain of each may, in fact, be only commensurate with the food actually consumed in each case; and thus, with great variation in the different pigs, with diets from one cause or another themselves really different, the total increase of the entire pen may still indicate, with some truth, the effects of the total food consumed in it—the smaller increase of the one pig with a deficient share of food being compensated by the larger gain of the other upon at the same time a larger and better share of food.

But to turn to the figures of the table. In the first 4 pens the Bean and Lentil mixture is given ad libitum; in Pen 1, without any other food; and we find that, with this very highly nitrogenous food alone, there is nearly as high a total gain, and a greater regularity of progress among the different pigs, and also throughout the several periods and the total period of the experiment, than in any other pen.

In Pen 2, besides the Bean and Lentil meal, there was an allowance of 2 lbs. of Indian-corn meal per pig per day; which, as we have said, contains much less of nitrogen, but more of the non-nitrogenous, starchy, and fatty matters, than the Beans and Len-

tils. Upon this mixed food the entire pen gives a greater increase than Pen 1 with its more highly nitrogenous diet. Pig No. 1 in this Pen 2 gave a much higher increase than either of the others, and a very regular one throughout the four periods; he was a large-framed hog, and grew very considerably as well as fattened. The other two pigs increase less than No. 1, though their increase is also very constant during the first three periods of the experiment; but, during the concluding fortnight they seem to have made much less progress. When they were killed, however, both these pigs were pronounced to be well fatted; and we shall presently see that the *consumption of food* in this pen decreased very much during the fourth period of the experiment; so that the probability is, that the reason of these two animals not increasing at the same rate as before, was that they were already ripe; from which cause both consumption and increase would naturally be lessened.

In Pen 3, 2 lbs. of Bran per pig per day is the limited food, and the Bean and Lentil mixture the complementary or ad libitum food. The Bran, which constituted the *limited food* of this pen, contains, weight for weight, more nitrogen than the Indian meal of Pen 2, but less than the Bean and Lentil mixture, which was the only food in Pen 1. The Bran, however, contains rather more fatty matter than the Beans and Lentils, but much less of other non-nitrogenous constituents than either the Beans and Lentils, or the Indian corn. Excepting in the item of fatty matter, then—and of this the amount is, after all, inconsiderable—the bran is much inferior to either the Beans and Lentils or Indian corn, but especially so in the non-nitrogenous starchy series of compounds. The result is, that, although all the animals start well on this food, they all afterwards more or less rapidly decline in their rate of increase. The character of the deficiency of the food in this pen is best seen by comparing the result with that of Pen 2, in which 2 lbs. of Indian corn—so rich in the non-nitrogenous constituents—are given, instead of the 2 lbs. of Bran. This comparison clearly points to the dependence of the animals upon a due supply of the non-nitrogenous constituents of food—however liberally they may be provided with the nitrogenous ones.

In Pen 4, with Beans and Lentils still as the ad libitum food, we have 2 lbs. per pig per day both of Indian meal and of Bran, as the limited food. This diet we should suppose to be decidedly superior to that of Pen 3, but inferior to that of Pen 2. The result is a much better *total* increase than in Pen 3, though less than in either Pens 1 or 2. There was, however, in this Pen 4 one pig which gained very rapidly, and indeed twice as much on the whole as either of its companions. This very prosperous

No. 1 pig was, compared with the others, a large-framed growing animal; and he was, moreover, a very obstinately masterful and selfish one, requiring the whip more frequently than any other of the entire Series. It is probable, therefore, that in spite of the care that was taken, he managed to secure more than his share of the best adapted food; and, besides this, he doubtless retarded the progress of the other two pigs by disturbing their repose and comfort.

In Pens 5, 6, 7, and 8, we have, instead of the Bean and Lentil mixture, Indian-corn meal as the ad libitum food; which, it will be borne in mind, contains much less of nitrogen, but much more of the non-nitrogenous constituents than the former.

In Pen 5 the Indian meal was given alone, ad libitum of course. One of the pigs on this food gained more than 2 lbs. a day during the first fortnight of the experiment; but the other two only about half as much. Before the end of this first period, however, it was observed, that this fast gaining pig, and one of the others, namely, No. 3, had large swellings on the side of their necks; and that at the same time their breathing had become much laboured. It was obvious that the Indian corn meal alone, was in some way a defective diet; and it occurred to us, that it was comparatively poor both in nitrogen and in mineral matter,—though we were inclined to suspect, that it was a deficiency of the latter, rather than of the former, that was the cause of the ill effects produced. We were at any rate unwilling so far to disturb the plan of the experiments as to increase the supply of nitrogenous constituents in the food; and accordingly determined to continue the food as before, but, at least, to try the effect of putting within the reach of the pigs, a trough of some mineral substances, of which they could take if they were disposed. The mixture which was prepared was as follows:—20 lbs. of finely sifted coal ashes, 4 lbs. of common salt, and 1 lb. of superphosphate of lime. A trough containing this mineral mixture was put into the pen at the commencement of the second period, and the pigs soon began to lick it with evident relish. From this time the swellings or tumours, as well as the difficulty in breathing, which probably arose from the pressure of the former, began to diminish rapidly. Indeed, at the end of this second period the swellings were very much reduced, and at the end of the third they had disappeared entirely. No. 1 pig, which increased the most of the three during the first, third, and total periods of the experiment, it is seen only gained 6 lbs. during the second period; he was, however, during that time the worst affected by disease as described above. As, however, his apparent increase was so great during the first and third periods, it is probable, that part at least of the deficiency in the intermediate period, was

due to some temporary circumstance connected with his health, owing to which the contents of his stomach, &c., were unusually small at the time of his second weighing. The other two pigs in this pen give considerably less total increase than No. 1, but their rate of progress is comparatively very regular: that of No. 2 is singularly so; and No. 3, which was one of those affected by the swellings, nevertheless gives a gradually increasing rate of gain from the commencement up to the end of the experiment. We shall find too, further on, that the animals were satisfied with less of this food, though so poor in nitrogen, in proportion to their weight, than, with one exception, of any of the others; it will also be seen, that in spite of the comparatively small supply of nitrogen, and the comparatively small actual increase in weight of the pigs, yet this increase is, in reality, somewhat high, when calculated in relation to the amount of food consumed. Nor could the quality of the meat have suffered much; for a dealer in pork, with a practised eye, selected and purchased the carcass of one of these pigs which had been diseased, from among the whole 36, after they had been killed and hung up. With these observations we may leave the result of this curious experiment for the present; but, before closing our statement of the facts of it, it may here be remarked, that, of the mineral mixture described above, 9 lbs. were consumed by the 3 pigs during the first fortnight of its use, 6 lbs. during the second, and 9 lbs. during the third.

In Pen 6, with Indian corn meal as the complementary or ad libitum food, 2 lbs. of Bean and Lentil meal constitutes the limited food. Upon this diet, which contains a larger amount of nitrogen than that of Pen 5, but still a very liberal supply of the *non*-nitrogenous constituents, all the pigs begin well, and Nos. 1 and 3 give a regular and high rate of increase up to the end of the experiment; averaging, indeed, very nearly 2 lbs. per head per day. No. 2 gives, indeed, the highest increase during the first fortnight, but a decreasing one in the succeeding periods of the experiment. This No. 2 pig, however, was much riper at the last than either of the others; so that his comparatively small rate of increase as the experiment proceeded, is in no way disparaging to the quality of the food, but rather otherwise. And if, as we shall find further on, less food is consumed in proportion to the weight of the animal as he approaches maturity, we may suppose that this pig still did ample justice to all the food he consumed. Taking this explanation of the comparatively small increase of the No. 2 pig, it may be said that the diet of this pen 6, has given, upon the whole, a good and uniform rate of increase.

In Pen 7 the limited food is 2 lbs. of Bran per head per day;

with still Indian corn as the ad libitum food. In this pen we have a very good total increase; but there is a great difference between the different pigs in this respect. No. 3 gives not only the highest total increase of any pig of the whole Series of 36, amounting to rather more than $2\frac{1}{2}$ lbs. per day, but his gain is exceedingly constant throughout the whole experiment. No. 2, on the other hand, gives a pretty uniform rate of increase, but a total amount considerably less than half that of No. 3, and very much less than No. 1. The pig No. 2 was, however, from the beginning, very much molested by the thriving No. 3, and indeed, for a time, frequently jumped out of his pen to avoid the ferocious attacks of his greedy neighbour. There is little doubt that he was prevented taking as much food as he would otherwise have done; and his deficient increase can scarcely be wondered at. No. 1 pig was also at first much molested; indeed, he lost the greater part of his tail in one engagement; his increase, therefore, was comparatively small at the commencement, but afterwards it was much better, averaging upon the whole rather more than $1\frac{3}{4}$ lbs. per day. Eventually this pig was the fattest among the whole 36; and this full ripeness is doubtless the reason of the gradually declining rate of increase during the last three periods of the experiment. Upon the whole, this diet of a small allowance of Bran and a liberal supply of Indian corn, may be pronounced a very good food, and to have yielded well. The limited quantity of Bran served somewhat to increase the supply of nitrogenous and mineral matters, and the large allowance of Indian corn provided a liberal amount, especially of fatty matter, and of the other important non-nitrogenous constituents of food.

In Pen 8 two lbs. of the Bean and Lentil mixture and 2 lbs. of Bran per pig per day was the fixed allowance; and Indian meal the complementary or ad libitum food. In this diet there would be a more liberal allowance of nitrogen than in either pens 5, 6, or 7, whilst there would be at the same time, enough of the Indian corn meal to provide a liberal supply of the important non-nitrogenous constituents. Every pig in this pen gave a good, and, upon the whole, a pretty regular increase, though they differed somewhat from one another in this respect; and they all grew considerably as well as fattened. No. 1 on this diet gives the highest increase in the entire Series of Pigs with one exception; and his daily gain in weight seemed to be on an average more than $2\frac{1}{2}$ lbs., with something like a gradually declining rate of increase from the commencement to the end of the experiment. No. 2 was not so fat as either of the others; and his increase, though still a fair one, was only about two-thirds that of No. 1. No. 3 increased nearly 2 lbs. per day, but less as he progressed, and, though well fatted, was by no means so fat as many others. The average

increase of this entire pen is more than 2 lbs. per head per day. It would appear that a small proportion of *Bran*, with otherwise highly nutritive food, is by no means unfavourable in the fattening food of the pig. The results of the next 4 pens, however, will show, that the limit of the usefulness of Bran as a fattening food is very soon reached; and that with 2 or 3 lbs. per pig per day of Beans and Lentils, or of Indian corn, or even of both, an unlimited supply of Bran in addition, is insufficient to enable the animals to do much more than keep up a good store condition.

In Pens 9, 10, 11, and 12, Bran was given as the unlimited or complementary food; in the three former with the other foods in limited quantity; in Pen 12, with all the foods ad libitum.

In Pen 9 the limited food during the first fortnight was 2 lbs. of Beans and Lentils per pig per day, with Bran ad libitum. Upon this diet No. 1 Pig only increased 7 lbs., No. 2, 2 lbs., and No. 3 nothing at all, during the fourteen days. In this food, with a limited supply of Beans and Lentils, and Bran ad libitum, which has yielded such a bad result, there was a more liberal supply of nitrogenous constituents than in many of the previous pens; and it will be seen further on that it was the *non*-nitrogenous matters that were wanting in this diet. We shall find, indeed, that beyond a somewhat narrow limit which is attained with almost any of our current fatting foods, any defect is much more likely to be connected with a deficiency of the important *non*-nitrogenous constituents than of the nitrogenous ones. This remark of course refers only to the quality of food *as such*, that is as a source of the support and increase of the animal, and not to its value as a means of *Manure*, which, in its turn, depends almost entirely upon the amount of *nitrogen* which the food contains. With such plain indications as the results of this pen afforded during the first fortnightly period, it was determined to increase from that time the daily allowance of beans and lentils from 2 lbs. to 3 lbs. Notwithstanding this increase in the allowance of the food, which, when given alone and in large quantity in Pen 1, yielded so large an increase, the gain in this pen continued to be scarcely more than one-third as much as the average in many of the pens. Two of the pigs indeed in this pen, Nos. 1 and 3, gave a somewhat regular though but small increase; but No. 2 gained only 6 lbs. during the entire period of 8 weeks. Almost from the commencement of the experiment this No. 2 pig became unwell, being as it were paralyzed and deprived of the use of its limbs; but as he had progressed quite as well as the average during the period preliminary to the exact experiment, it was supposed that this was only the natural effect of the defective diet, and hence it was decided not to alter the food, but to let him take his course, in order to obtain the

full and marked effect of this food in comparison with that of the other pens.

In Pen 10, Bran was still the ad libitum food; but Indian-corn meal, instead of Beans and Lentils, as in Pen 9, was the limited food. The diet of Pen 10 would therefore contain less of the nitrogenous and more of the non-nitrogenous constituents, than that of Pen 9. The result of this is, upon the whole, a decidedly better rate of increase. During the first period, however, when only 2 lbs. of the limited food were given, there was, it is true, a loss of weight of 8 lbs. in one animal; but after the Indian corn was increased to 3 lbs. per pig per day, as the Beans and Lentils had been in Pen 9, this pig, as well as the others, gave a pretty regular, though still comparatively small increase in weight. The progress upon this diet, could however, scarcely be considered more than that of good store food; though nevertheless it is clear, that the addition of the low nitrogenous and highly-starchy Indian-corn to the unlimited Bran, gave a much better food, than when, instead of the former, the highly nitrogenous Beans and Lentils had been given, as in Pen 9.

In Pen 11, with Bran still as the complementary or unlimited food, the limited allowance is more liberal than in the two preceding pens; namely, 2 lbs. of the Bean and Lentil mixture, and 2 lbs. of Indian-corn meal also. The result is a marked improvement, as compared with Pens 9 and 10. The proportion of Bran in the food is, however, still apparently much too high for the purpose of rapid fattening. What really were the actual relative proportions of the limited to the unlimited food, is a question we need not stop to consider in this place; but full particulars on this point are given in Tables, pp. 489-491, in respect to the food in all the pens. To proceed, then, with the results of the food in this Pen 11, it may be remarked, that the pigs fed upon it grew rather than merely fattened; and eventually they were, compared with those in many of the other pens, little more than half-fat. From some unexplained cause, one of the pigs in this pen was less regular in his rate of progress than the rest; but we think that the results, as a whole, may safely be taken as giving a fair measure of the comparative feeding value of the food employed.

In the 12th, and last Pen of this Series, as before observed, each of the three descriptions of food was allowed ad libitum; that is to say, one trough was kept constantly supplied with the Bean and Lentil mixture, another with Indian-corn meal, and another with Bran; so that in this case the pigs were allowed to fix for themselves entirely, the quantity and proportion of the several foods. It might have been supposed, that by this arrangement the animals would be placed under more favourable circumstances for rapid progress than in any of the other pens. But, if the result

were to be taken as a strict measure of the comparative productive value of the food consumed, we must decide quite otherwise. Thus one of the pigs, No. 2, though during the first fortnight he gave a pretty fair increase, from that time became unwell and lost the use of his limbs, as in the instance already noticed. He was entirely unable to walk, and could scarcely support himself at the trough, and, as seen in the Table he only gained 3 lbs. in the second period, and only 1 in the third; though during the fourth he somewhat recovered, and then gave an increase of 17 lbs. The other two pigs in this pen, however, gave a very fair increase, at a gradually diminishing rate as the experiment proceeded, and eventually they gave the highest proportions of *dead*-weight to live, of any of the entire series of 36 pigs; and they were, therefore undoubtedly well ripened. We may perhaps fairly conclude that the bad result of the No. 2 pig seriously reduced the apparent productive value of the food in this pen: at any rate, it would seem contrary to the facts to suppose, that in consulting their own inclination, this was not calculated to guide the animals to the selection best adapted to their progress, when we find, that under this arrangement two of the pigs matured more completely than any others of the entire Series. It is to be regretted, that the exact proportions of the several foods actually consumed by the two pigs who gave such a good result, cannot be stated separately from that of the other and faulty pig. We shall find, however, that the results of the entire pen in this respect are still of considerable interest, as will be seen in the following table:—

TABLE IV.

(EXPERIMENTS WITH PIGS.—SERIES I)

Showing the Proportions in 100 Parts, in which the several Foods were consumed in Pen 12, during the 4 successive Periods of the Experiment.

	Beans and Lentils.	Indian Corn.	Bran.	Total Food.
1st Period of 14 Days	63	30	7	100
2nd ditto	$51\frac{1}{3}$	45	$3\frac{2}{3}$	100
3rd ditto	$38\frac{1}{4}$	$56\frac{1}{4}$	$5\frac{1}{2}$	100
4th ditto	$43\frac{1}{5}$	52	$4\frac{4}{5}$	100
Mean of the 8 Weeks	$49\frac{9}{10}$	$45\frac{9}{10}$	$4\frac{1}{5}$	100

If we suppose, as we fairly may do, that the two healthy and flourishing pigs in this pen mainly determined these proportions, in which the several foods were taken, it is plain, that as they ripened, they naturally selected less of the nitrogenous and more of the starchy and fatty food. There is, indeed, a trifling exception to this rule in the last period of the experiment, during which

43¼ per cent. of the food taken was Beans and Lentils; whilst in the previous period there had been consumed of these only 38¼ per cent.; and again, with 56¼ per cent. of the Indian-corn in the third period, there is only 52 per cent. in the fourth. But, as it was during the fourth period that the sickly pig improved and took its food more freely, may we not conclude that the increased proportion of the Bean and Lentil mixture consumed during this period was due to his freer consumption of it? Notwithstanding this irregularity, however, the proportion of Beans and Lentils consumed in the last period in the entire pen, is only two-thirds as great as that in the first; whilst, on the other hand, the Indian-corn, which in the first period only constituted 30 per cent. of the food consumed, amounted in the fourth period to as much as 52 per cent.

At any rate, the general fact of a considerably decreasing demand for nitrogenous constituents, and an increasing one for the non-nitrogenous ones, as the animals mature, is sufficiently marked. It is, too, of considerable interest, and serves to justify the practice of diminishing the supply of the leguminous seeds (peas, beans, &c.), and increasing that of barley-meal to the fatting-pig as he approaches maturity, as is the pretty general custom when a liberal system of fattening is adopted.

Before leaving the last table it may be noticed, that the average proportion of Bran taken by these pigs was less than 5 per cent. of their total food.

We have thus far given an account of the selection and manangement of the pigs in this First Series of experiments—a statement of the weight of the animals—a general description of the foods allotted to the several pens—and a somewhat detailed account of the progress in each pen, and even of each pig, upon the 12 different dietaries which it comprised. We have thought it desirable, indeed, in reference at any rate to the First Series of experiments, somewhat minutely to call attention to any such irregularities within the pens as might be supposed to affect the legitimacy of comparisons founded upon the gross results of the entire pen. These observations will have given the reader a considerable insight into the general character of the results; and they will enable him to form his own conclusions respecting them. But we think it will be seen, that, notwithstanding the irregularities that have been pointed out, there is still much of consistency in the indications of the mere gross result of each pen, upon which henceforth we shall found our conclusions; and we shall therefore go into less detail on these points in the account of the other Series of experiments.

We have yet to consider however, much more minutely, the influence of the composition of the food upon the rate of con-

sumption, and the progress of the pigs in this First Series of experiments. But these and some other points will be discussed with more advantage in reference to the results of all the series together. Before proceeding further, therefore, with this First Series, we shall describe thus far, the particulars and results of a Second and of a Third Series of experiments with Pigs.

The First Series of experiments—in which Beans and Lentils were the highly nitrogenous food, Indian corn meal the comparatively non-nitrogenous food, and Bran the more bulky and less nutritious one—had afforded very clear indications as to the comparative feeding values of the different classes of constituents which characterise these different foods. It was decided, therefore, to conduct the Second Series on a somewhat similar plan. In this case, however, the Indian corn of the former series was substituted by the more usual pig-food, *Barley-meal.* It was also thought desirable to alter the proportions of the limited to the unlimited food—3 lbs. instead 2 lbs. per pig per day of limited food being now given when it consisted of the Bean and Lentil mixture or of Barley-meal, and only 1 lb. when Bran. It was further determined in no case to give Bran alone, as the complementary or ad libitum food.

Like the former one, this Series consisted of 12 pens with 3 pigs in each. Pens 1, 2, 3, and 4 had, as before, the Bean and Lentil mixture as the ad libitum food. In Pens 5, 6, 7, and 8, Barley-meal was the ad libitum food. In Pens 9, 10, 11, and 12 there was no allowance of limited food; but in Pens 9 and 10 a mixture of certain proportions of the several foods was given ad libitum; and in Pens 11 and 12 a similar mixture, but containing different proportions respectively of the more and the less highly nitrogenised foods.

The following is a detailed description of the 12 dietaries of this Second Series:—

Pen 1. Bean and Lentil meal (equal parts), ad libitum.

Pen 2. 3 lbs. per pig per day of Barley-meal; and the Bean and Lentil mixture, ad libitum.

Pen 3. 1 lb. of Bran per pig per day; and the Bean and Lentil mixture, ad libitum.

Pen 4. 3 lbs. of Barley-meal and 1 lb. of Bran per pig per day; and Bean and Lentil mixture, ad libitum.

Pen 5. Barley-meal only, ad libitum.

Pen 6. 3 lbs. per pig per day of Bean and Lentil mixture; and Barley-meal, ad libitum.

Pen 7. 1 lb. of Bran per pig per day; and Barley-meal, ad libitum.

Pen 8. 3 lbs. of Bean and Lentil mixture and 1 lb. of Bran per pig per day; and Barley-meal, ad libitum.

Pen 9. A mixture of 1 part Bran, 2 parts Barley-meal, and 3 parts Bean and Lentil mixture, ad libitum.

Pen 10. Duplicate of Pen 9.

Pen 11. A mixture of 1 part Bran, 2 parts Bean and Lentil mixture, and 3 parts Barley-meal, ad libitum.

Pen 12. Duplicate of Pen 11.

On April 26th, 1850, the pigs were allotted by weight to the different pens. They were taken from a stock of 40, all of about nine months old, which had been bought at different styes and markets, in lots respectively of four, nine, eight, eight, and eleven; and, as before, they were on the following day changed from pen to pen, so as to disturb as little as possible the weight within each pen, and at the same time to secure greater equality as to the character of the animals between pen and pen.

Table V., which follows, shows the weights of the pigs in each pen as thus allotted.

TABLE V.

(EXPERIMENTS WITH PIGS.—SERIES II)

Showing the Weights of the Pigs (in lbs.) when Allotted to the Pens, April 26, 1850.

Nos. of the Pigs.	Pen 1	Pen 2	Pen 3	Pen 4	Pen 5	Pen 6	Pen 7	Pen 8	Pen 9	Pen 10	Pen 11	Pen 12
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	138	138	138	137	136	134	134	133	129	128	127	127
2	117	125	124	120	122	123	120	120	126	125	124	127
3	115	105	106	114	111	112	112	113	116	116	116	116
Total weights of 3 pigs	370	368	368	371	369	369	366	366	371	369	367	370

After the allotment and this first weighing, all the pens were supplied with a mixture (given ad libitum) of one part Bran, one part Bean and Lentil meal, and one part Barley-meal. Upon this food they were kept for 13 days prior to commencing the exact experiment. There was, as usual, some inconvenience during this preliminary period until the pigs became accustomed to their new situation and new companions; and this of course accounts for some of the irregularity in increase during this period, as shown in Table VI., which follows.

Table VI.

(Experiments with Pigs.—Series II)

Showing the Weight (in lbs.) Gained during the 13 Days of the Preliminary Period, and also the Actual Weights at the Commencement of the exact Experiment, May 9, 1850.

Nos. of the Pigs.	Pen 1		Pen 2		Pen 3		Pen 4		Pen 5		Pen 6	
	Gain in 13 Days.	Weight May 9.	Gain in 13 Days.	Weight May 9.	Gain in 13 Days.	Weight May 9.	Gain in 13 Days.	Weight May 9.	Gain in 13 Days.	Weight May 9.	Gain in 13 Days.	Weight May 9.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	20	158	27	165	17	155	16	153	30	166	15	149
2	16	133	23	148	6	130	16	136	27	149	20	143
3	27	142	28	133	14	120	28	142	22	133	24	136
Totals .	63	433	78	446	37	405	60	431	79	448	59	428

Nos. of the Pigs.	Pen 7		Pen 8		Pen 9		Pen 10		Pen 11		Pen 12	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	19	153	18	151	18	147	7	135	23	150	0	127
2	23	143	19	139	17	143	14	139	12	136	10	137
3	18	130	16	129	24	140	21	137	23	139	22	138
Totals .	60	426	53	419	59	430	42	411	58	425	32	402

On May 9th, then, the exact experiment was commenced; and the pigs were now put upon the dietaries which have been already described. The management, as to the supply of food, &c., was the same as before. The pigs themselves were weighed every 14 days; and the experiment was continued for four such periods —that is, for a total period of 8 weeks.

The following Table (VII.) gives the increase in weight per pig and per pen in this Second Series.

Table VII.

(Experiments with Pigs.—Series II)

Showing the *Gain in Weight* (in lbs.) upon each of the 12 different Dietaries, of *each Pig*, and of the *Pen of Three Pigs*, during each Period of 14 Days, and during the entire experimental Period of 8 Weeks.

Nos. of Pigs.	PEN 1 Beans and Lentils (equal parts) Ad Libitum.					PEN 2 3 lbs. Barley Meal per Pig per Day. Beans and Lentils (equal parts) Ad Libitum.				
	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.
1	33	7	13	24	77	41	22	28	29	120
2	−3	4	Died June 9	..	1	10	14	25	16	65
3	23	34	25	35	117	25	20	27	27	99
3 pigs. .	53	45	38	59	195	76	56	80	72	284

TABLE VII.—*continued.*

(EXPERIMENTS WITH PIGS.—SERIES II)—*continued.*

Nos. of Pigs.	PEN 3 1 lb. Bran per Pig per Day. Beans and Lentils (equal parts) Ad Libitum.					PEN 4 3 lbs. Barley Meal and 1 lb. Bran per Pig per Day. Beans and Lentils (equal parts) Ad Libitum.				
	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	20	16	22	25	83	23	21	24	19	87
2	25	12	25	19	81	26	16	17	Killed June 28	59
3	24	16	18	20	78	24	21	31	18	94
3 pigs .	69	44	65	64	242	73	58	72	37	240

Nos. of Pigs.	PEN 5 Barley Meal Ad Libitum.					PEN 6 3 lbs. Bean and Lentil Meal per Pig per Day. Barley Meal Ad Libitum,				
1	Died May 16	24	28	10	62	35	15	11	14	75
2	37	35	41	29	142	39	23	28	23	113
3	29	19	21	18	87	28	15	20	Died June 20	63
3 pigs .	66	78	90	57	291	102	53	59	37	251

Nos. of Pigs.	PEN 7 1 lb. Bran per Pig per Day. Barley Meal Ad Libitum.					PEN 8 3 lbs. Bean and Lentil Meal and 1 lb. Bran per Pig per Day. Barley Meal Ad Libitum.				
1	30	20	21	24	95	35	17	29	20	101
2	35	22	17	22	96	— 3	Died May 29	..	..	—3
3	29	21	15	21	86	37	16	22	14	89
3 pigs .	94	63	53	67	277	69	33	51	34	187

TABLE VII.—*continued.*

(EXPERIMENTS WITH PIGS.—SERIES II)—*continued.*

Nos. of Pigs.	PEN 9 Mixture of 1 part Bran, ,, 2 parts Barley Meal, and ,, 3 parts Beans & Lentils, } Ad. Libitum.					PEN 10 Duplicate of Pen 9.				
	1st Period 14 Days.	2nd Period 14 Days.	3rd Period 14 Days.	4th Period 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.
1	−3	20	28	Died June 20	45	28	24	19	22	93
2	32	21	22	21	96	29	14	18	18	79
3	31	30	25	26	112	31	33	20	27	111
3 pigs .	60	71	75	47	253	88	71	57	67	283

Nos. of Pigs.	PEN 11 Mixture of 1 part Bran, ,, 2 parts Bean and Lentil Meal, and 3 parts Barley Meal, } Ad. Libitum.					PEN 12 Duplicate of Pen 11.				
1	32	24	22	27	105	43	22	24	21	110
2	41	27	18	24	110	31	16	25	26	98
3	27	20	24	24	95	30	17	24	28	99
3 pigs .	100	71	64	75	310	104	55	73	75	307

An inspection of this Table (VII.) shows that five of the pigs of this second series died during the experiment. It would appear that we were very unfortunate in one of the purchases, for all of these five pigs belonged to one of the lots of eight, and hence the loss was most probably due to the bad constitution of the animals. The weather was, however, excessively hot during part of the period of this experiment, and therefore unfavourable to the health of pigs fattening on a very liberal diet. It was evident that many did suffer from this cause; and that some of the losses were indeed in a great measure attributable to it.

These accidents, of course render it quite impossible to form any judgment of the value of the different foods by a comparison of the *actual gross results* of pen with pen. But we shall find, that, even with this greater irregularity in the amounts of actual increase obtained per pen than in the previous series, there is still, when we come to consider this increase in relation to

the amounts of food consumed, much of consistency in the results throughout this Series; and also, that their indications agree very closely with those of the previous Series. If too, in looking at this Table of the increase of each pig, we exclude those which died, we shall see, that upon the whole, the actual increase per pig upon any particular food is seldom inferior in this Series, and sometimes superior, to that upon the food most nearly corresponding with it in the previous Series.

Having, then, thus shortly called attention to the irregularities in the results of this Second Series, we shall not go into the same detail on these points as we thought it well to do in reference at least to one set of the experiments; for, as we have already observed, notwithstanding the numerous incidental circumstances which were then pointed out affecting the actual increase of the pigs, it will still be found, that there was a great consistency throughout, in the relationship of increase to food consumed; and, as we have said, it will be seen too, that there was a similar consistency in the results of this Second Series, both when compared among themselves and with those of Series I.

But, before going further into these points, we will here briefly notice the arrangement and actual results of the Third and last Series of experiments.

This Third Series consists of 5 pens, with 4 pigs in each. These five experiments were, however, not all conducted at the same time; those with the first three pens being simultaneous with the First Series, and those with Pens 4 and 5 with Series II. Indeed, the pigs of this series were those which had been thrown out in making the selection from the whole stocks for the other two series; so that those in some of the pens were not, in point of weight or similarity, well calculated for comparison with the rest. Thus, although the pigs in Pens 1 and 2, of Series III., compared very well with each other in these respects, and were all exceedingly fine pigs, and very kindly feeders, those in Pen 3 were all odd pigs, and of very different weights and quality from the former. Pens 4 and 5, again, compared pretty well with each other as to the pigs allotted to them, but these 8 pigs were only about 7 months old, and they were more finely framed than those in the other pens, and did not therefore assort well with them. The five pens are, however, thus classed together on account of the general similarity throughout in the description of the food employed: and, notwithstanding the circumstances which have been mentioned, we shall find further on, that—with some peculiarity of result in this series, as compared with the former, arising from the character of the food employed—there is still, on comparing these five pens one with another, more of consistency than we might have anticipated, when we

consider the increase obtained, in relation to the constituents of food consumed.

In Tables VIII. and IX., which follow, we have the weights of the pigs in this Series when allotted to the pens—their gain in weight during the preliminary periods—and their weights at the commencement of the exact experiment.

Table VIII.

(Experiments with Pigs.—Series III)

Showing the Weights of the Pigs (in lbs.) when allotted to the Pens (Pens 1, 2, and 3, Feb. 2, 1850—Pens 4 and 5, April 26, 1850.)

Nos. of the Pigs.	Pen 1	Pen 2	Pen 3	Pen 4	Pen 5
	lbs.	lbs.	lbs.	lbs.	lbs.
1	119	166	Weights not taken.	104	104
2	156	143		101	100
3	140	126		95	100
4	145	141		96	86
Total weights of 4 pigs . . .	560	560	—	396	390

Table IX.

(Experiments with Pigs.—Series III)

Showing the Weight (in lbs.) gained during the preliminary Period; and also the actual Weights at the commencement of the exact Experiment (Feb. 14, 1850, for Pens 1, 2, and 3; May 9, 1850, for Pens 4 and 5.)

Nos. of the Pigs.	Pen 1		Pen 2		Pen 3		Pen 4		Pen 5	
	Gain in 12 Days.	Weight Feb. 14.	Gain in 12 Days.	Weight Feb. 14.	Gain in 12 Days.	Weight Feb. 14.	Gain in 13 Days.	Weight May 9.	Gain in 13 Days.	Weight May 9.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	20	139	26	192	—	123	16	120	20	124
2	15	171	15	158	—	138	19	120	19	119
3	18	158	14	140	—	129	22	117	13	113
4	19	164	16	157	—	143	17	113	22	108
Totals . . .	72	632	71	647	—	533	74	470	74	464

As seen in Table VIII., the pigs in Pen 3 were not weighed when first allotted to the pens; and hence their gain in weight during the preliminary period cannot be given, but only their actual weight at the commencement of the experiment. The gain in weight in Pens 1, 2, 4, and 5 is seen to be singularly uniform during the preliminary periods; and the actual weights at the commencement of the experiment, of Pens 1 and 2 respectively, and again of Pens 4 and 5, agree very well together.

These five pens were devoted to the trial, as pig-food, of *dried Newfoundland cod-fish*—an article which could be supplied in large quantities, and at a moderate price, were it found available for this purpose. The experiments were so arranged as to ascertain in what proportions it could be most advantageously mixed with other foods: the dried cod-fish containing, as will be seen in our Table of Composition, a much higher percentage of nitrogen than any other current pig-food. Hence, if it were found otherwise available, it would yield a manure of corresponding richness.

It should be stated, that during the preliminary period, the pigs in Pens 1, 2, and 3 of this Series were supplied with the same food as had been given in the 12 pens of the First Series; namely, one part Bean and Lentil mixture, one part Indian corn, and two parts Bran. Pens 4 and 5, however, were provided, during their preliminary period, with half a pound per pig per day of the dried Cod-fish, and were allowed to take ad libitum of a mixture of one part Bean and Lentil meal, one part Barley-meal, and one part Bran. The Cod-fish was in all cases prepared by boiling in water; and a portion of the other food was then stirred in with the soup thus obtained. It is scarcely necessary to mention that in all the experiments with pigs the food was mixed with water before it was put into the troughs.

The allowance of food to the several pens of the Third Series was as follows:—

Pen 1. 2 lbs. of dried Cod-fish per pig per day: with a mixture of equal parts of Indian meal and Bran, ad libitum.

Pen 2. 2 lbs. of dried Cod-fish per pig per day; with Indian meal, ad libitum.

Pen 3. Cod-fish, and a mixture of equal parts of Indian meal and Bran, each ad libitum.

Pen 4. 1 lb. of Cod-fish per pig per day; with a mixture of 2 parts Barley-meal and 1 part Bran, ad libitum.

Pen 5. 1 lb. of Cod-fish per pig per day; with Barley-meal, ad libitum.

Table X. gives the increase of each pig, and of each pen, upon these five dietaries, during each fortnightly period, and the total periods of eight weeks.

TABLE X.

(EXPERIMENTS WITH PIGS.—SERIES III)

Showing the *Gain in Weight* (in lbs.) upon each of the Five different Dietaries—of *each Pig*, and of the *Pen of Four Pigs*—during each Period of 14 Days—and during the entire Experimental Period of 8 Weeks.

Pig Nos.	PEN 1 2 lbs. Cod Fish per Pig per day. Bran and Indian-meal (equal parts) Ad Libitum.					PEN 2 2 lbs. Cod Fish per Pig per day. Indian-meal Ad Libitum.					PEN 3 Bran and Indian-meal (equal parts), and Cod Fish, each Ad Libitum.					PEN 4 1 lb. Cod Fish per Pig per day. Mixture of 2 parts Barley-meal and 1 part Bran Ad Libitum.					PEN 5 1 lb. Cod Fish per Pig per day. Barley-meal Ad Libitum.				
	1st Period. 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	35	14	13	10	72	20	28	37	30	115	39	21	11	21	92	23	27	13	20	83	33	27	24	17	101
2	27	25	25	25	102	20	30	13	28	91	23	20	17	14	74	21	15	16	12	64	31	23	23	21	98
3	-17	31	22	21	57	39	29	32	22	122	19	17	16	16	68	27	19	19	18	83	44	25	22	3	94
4	18	26	25	23	92	-3	17	24	23	61	1	20	16	15	52	19	16	-3	39	71	30	23	21	9	83
4 Pigs.	63	96	85	79	323	76	104	106	103	389	82	78	60	66	286	90	77	45	89	301	138	98	90	50	376

As the experiment proceeded with Pens 1, 2, and 3, it was obvious that the fixed allowance of 2 lbs. of Cod-fish per pig per day, in the two former, was more than they would have taken had it not been so mixed with their other food as to oblige them to do so. It was evident, too, that the proportion of one part Bran to one part only of the Indian meal, in the ad libitum food of Pens 1 and 3, was also too great. In Pens 4 and 5, therefore, as the Table shows, only 1 lb. of Cod-fish per pig per day was given as the limited food; and in Pen 4, where Bran was given in the ad libitum food, the mixture was composed of only one part Bran to two parts of the Barley-meal.

The Table shows at a glance that there was throughout this Series, with Cod-fish, a very fair rate of increase per head; and we shall see further on, that the increase was also comparatively high in relation to the amount of food consumed. We observe, too, a marked superiority in Pen 2, where the Indian meal was given alone as ad libitum food, over Pen 1, where it was mixed with Bran; and the same in Pen 5 over Pen 4; the Barley-meal being mixed with Bran in the latter, and given alone in the former. This is only what we might expect, and the result is very consistent in the two cases.

The pigs in Pens 1 and 2 of this Cod-fish Series were exceedingly fat; they indeed looked better than any, either in this or in either of the other Series. We shall have occasion to remark again on this experiment further on.

Before leaving the actual experimental results of these three Series of Pig experiments, and considering them more closely when brought by calculation to one uniform standard of comparison, or more minutely in reference to the chemical composition of the foods, it may be convenient to show the average *weekly* consumption *per head* of the unlimited, as well as of the limited, food; and also the average *weekly increase* obtained *per head* during each period, and the total period, in each of the 29 pens which the three Series of experiments comprise. These particulars are given for the several Series respectively in Tables XI., XII., and XIII., which follow.

Table XI.

(Experiments with Pigs.—Series I)

Showing the Average Weekly Consumption of Food, and Increase in Weight per Head, during each Period, and the total Period of the Experiment.

Pen, Nos., &c.		Description, and average quantities of Food, consumed per Pig, per Week (lbs.).		Average Weekly Increase in Live Weight (lbs.) per Pig, during each Period, and the total Period of the Experiment.				
Pen	Pigs	Limited Foods.	Ad Libitum Foods.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Average of 8 Weeks.
1	3	None	63 lbs. bean and lentil meal (equal parts)	12·83	13·83	12·00	11·83	12·62
2	3	14 lbs. Indian meal .	52 lbs. ditto .	16·00	15·66	14·00	10·33	14·00
3	3	14 lbs. bran . . .	$40\frac{1}{4}$ lbs. ditto .	13·83	10·00	3·66	5·83	8·33
4	3	14 lbs. Indian meal. 14 lbs. bran . . .	$31\frac{1}{2}$ lbs. ditto .	11·50	8·83	9·66	12·00	10·50
5	3	None	$45\frac{1}{4}$ lbs. Indian meal	9·66	6·00	12·00	9·18	9·21
6	3	14 lbs. bean and lentil meal (equal parts)	$44\frac{1}{4}$ lbs. ditto .	15·18	12·66	9·83	12·00	12·42
7	3	14 lbs. bran . . .	$44\frac{1}{4}$ lbs. ditto .	11·00	14·67	13·83	12·00	12·87
8	3	14 lbs. bean and lentil meal (equal parts), 14 lbs. bran . .	$36\frac{3}{4}$ lbs. ditto .	17·50	14·50	11·18	14·66	14·46
9	3	14 lbs. bean and lentil meal (equal parts)	18 lbs. bran . . .	1·50	5·00	4·83	5·33	4·16
10	3	14 lbs. Indian meal .	$23\frac{1}{2}$ lbs. ditto . .	0·83	6·83	5·83	5·50	4·75
11	3	14 lbs bean and lentil meal (equal parts), and 14 lbs. Indian meal	18 lbs. ditto . . .	9·33	6·50	6·50	7·33	7·42
12	3	None	$28\frac{1}{2}$ lbs. bean and lentil meal (equal parts) . . . . $25\frac{1}{2}$ lbs. Indian meal 3 lbs. bran . . .	15·83	10·83	7·00	8·66	10·58

Table XII.

(Experiments with Pigs.—Series II)

Showing the Average weekly Consumption of Food and Increase in Weight per Head during each Period, and the Total Period of the Experiment.

Pen, Nos., &c.		Description and average quantities of Food consumed per Pig, per Week (lbs.).		Average Weekly Increase in Live Weight (lbs.) per Pig, during each Period, and the Total Period of the Experiment.				
Pen	Pigs	Limited Foods.	Ad Libitum Foods.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Average of 8 Weeks
1	3	None	44 lbs. bean and lentil meal (equal parts).	8·83	7·50	9·50	14·75	10·14
2	3	21 lbs. barley meal .	51½ lbs. ditto .	12·67	9·33	13·33	12·00	11·83
3	3	7 lbs. bran . . .	52¾ lbs. ditto .	11·50	7·33	10·83	10·67	10·08
4	3	21 lbs. barley meal and 7 lbs. bran.	33 lbs. ditto .	12·17	9·67	12·00	9·25	10·77
5	3	None	68½ lbs. barley meal	11·00	13·00	15·00	9·50	12·12
6	3	21 lbs. bean and lentil meal (equal parts)	37¾ lbs. ditto .	17·00	8·83	9·83	9·25	11·23
7	3	7 lbs. bran . . .	57½ lbs. ditto .	15·67	10·50	8·83	11·17	11·54
8	3	21 lbs. bean and lentil meal (equal parts) and 7 lbs. bran	25 lbs. ditto .	11·50	8·25	12·75	8·50	10·25
9	3	None	61½ lbs. of mixture of 1 part bran, 2 parts barley meal, and 3 parts bean and lentil meal.	10·00	11·83	12·50	7·83	10·54
10	3	None	64¾ lbs., duplicate of Pen 9.	14·67	11·83	9·50	11·17	11·79
11	3	None	65 lbs. of mixture of 1 part bran, 2 parts bean and lentil meal, and 3 parts barley meal.	16·67	11·83	10·67	12·50	12·92
12	3	None	64 lbs., duplicate of Pen 11.	17·33	9·17	12·17	12·50	12·79

TABLE XIII.

(EXPERIMENTS WITH PIGS.—SERIES III)

Showing the *Average weekly Consumption* of Food and Increase in Weight *per Head,* during each Period, and during the total Period of the Experiment.

Pen, Nos., &c.		Description and average quantities of Food consumed, per Pig, per Week (lbs.).		Average Weekly Increase in Live Weight (lbs.) per Pig during each Period, and the total Period of the Experiment.				
Pen	Pigs	Limited Foods.	Ad Libitum Foods.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Average of 8 Weeks
1	4	14 lbs. cod-fish.	47 lbs. of mixture of bran and Indian meal (equal parts).	7·87	12·00	10·62	9·87	10·09
2	4	14 lbs. cod-fish .	$45\frac{1}{4}$ lbs. Indian meal . .	9·50	13·00	13·25	12·87	12·15
3	4	None . . .	47 lbs. of mixture of bran and Indian meal (equal parts), and $7\frac{1}{2}$ lbs. cod-fish.	10·25	9·75	7·50	8·25	8·94
4	4	7 lbs. cod-fish .	49 lbs. of mixture of 2 parts barley meal and 1 part bran.	11·25	9·62	5·62	11·12	9·40
5	5	7 lbs. cod-fish .	$57\frac{1}{2}$ lbs. barley meal . .	17·25	12·25	11·25	6·25	11·75

From these Tables we learn the fact that the pigs consumed, on an average, about 60 lbs. of corn per head per week—or nearly 9 lbs. per head per day; and that where the quality of the food was good, they yielded from 10 lbs. to 12 lbs. of increase in live weight per head per week—or about $1\frac{1}{2}$ lb. per head per day.

The amounts of food consumed per week, as given in these Tables (XI., XII., XIII.) are, it will be remembered, the averages of the whole period calculated *per head;* and those of the average weekly increase produced are also calculated per head; but the latter is given for each separate period, as well as for the total period. In the Tables which next follow, however (XIV., XV., XVI.), we have the weekly consumption of food *per* 100 *lbs. live weight of animal,* instead of per head; and calculated for each period of the experiment separately, instead of only for the total period. We have now, too, instead of the rate of increase *per head* during each separate period, the amount of increase obtained *for each* 100 *lbs. of food consumed.* In these Tables, therefore, we have the rate of *consumption* and of *increase,* during the successive periods of the experiment—each calculated to a uniform standard. And, it will be seen, that the results as thus arranged, clearly bring to view the influence of the progress of the animal, both upon the rate of consumption of food, and upon its productiveness—as already briefly alluded to, when commenting upon the results of Pen 12 of the First Series of experiments. We shall call attention to these Tables somewhat in detail.

Table XIV.

(Experiments with Pigs.—Series I)

Showing the Average Weekly Consumption of Food per 100 lbs. Live Weight of Animal—and also the Increase in Weight obtained by the Consumption of every 100 lbs. of Food, during each of the Successive Periods, and the Total Period of the Experiment.

Pen Nos.	Description and Quantities of Limited Food per Pig per Day.	Description of Ad Libitum or Complementary Food.	Division I. Average Weekly Consumption of Fresh Food, per 100 lbs. Live Weight of Animal.					Division II. Increase obtained by the Consumption of 100 lbs. Fresh Food.					Average Weekly Consumption of Food per 100 lbs. Live Weight of Animal.
			1st Period, 14 days.	2nd Period, 14 days.	3rd Period, 14 days.	4th Period, 14 days.	Total Period, 8 weeks	1st Period, 14 days.	2nd Period, 14 days.	3rd Period. 14 days.	4th Period, 14 days.	Total Period, 8 weeks	
1	None	Bean and lentil meal	37·2	36·7	30·0	26·6	32·0	21·6	20·8	18·8	18·9	20·0	32·0
2	2 lbs. Indian corn meal	Ditto	39·1	37·4	32·2	25·7	33·6	26·1	22·2	20·0	16·6	21·2	33·6
3	2 lbs. bran	Ditto	40·6	34·8	24·7	22·4	31·2	22·1	16·1	7·9	12·9	15·4	31·2
4	2 lbs. bran and 2 lbs. Indian corn meal	Ditto	38·3	31·2	31·7	29·9	32·3	19·5	16·3	15·8	18·7	17·6	32·3
		Means	38·8	35·0	29·6	26·1	32·3	22·3	19·0	15·6	16·8	18·5	32·3
5	None	Indian corn meal	33·7	23·3	26·9	19·0	25·1	18·7	15·2	23·8	23·1	20·3	25·1
6	2 lbs. bean and lentil meal	Ditto	40·0	32·1	27·0	20·8	29·5	23·2	20·6	17·0	24·5	21·3	29·5
7	2 lbs. bran	Ditto	37·9	32·9	30·1	25·2	30·7	19·4	25·5	22·6	20·7	22·1	30·7
8	2 lbs. bran and 2 lbs. bean and lentil meal	Ditto	41·8	34·8	29·0	24·8	32·1	25·9	21·5	17·5	24·1	22·3	32·1
		Means	38·3	30·8	28·2	22·4	29·3	22·0	21·0	20·2	23·1	21·5	29·3
9	*2 lbs. bean and lentil meal	Bran	26·0	25·2	23·5	20·9	23·3	4·0	13·1	12·8	14·9	11·2	23·3
10	*2 lbs. Indian corn meal	Ditto	26·5	29·9	28·1	26·5	27·2	2·2	15·5	13·0	12·1	11·1	27·2
11	2 lbs. bean and lentil meal, and 2 lbs. Indian corn meal	Ditto	33·7	28·2	24·6	21·8	26·9	18·4	13·8	14·7	17·4	16·1	26·9
		Means	28·7	27·8	25·4	23·1	25·8	8·2	14·1	13·5	14·8	12·8	25·8
12	None	Bean and lentil meal, Indian corn meal, and bran	40·9	34·3	26·9	20·6	30·8	24·3	17·5	12·8	19·2	18·6	30·8
		Mean of 12 Pens	36·3	31·7	27·9	23·7	29·5	18·8	18·2	16·4	18·6	18·1	29·5

* Increased to 3 lbs. after the first period of the experiment.

Table XV.

(Experiments with Pigs.—Series II)

Showing the Average Weekly Consumption of Food per 100 lbs. Live Weight of Animal—and also the Increase in Weight obtained by the Consumption of every 100 lbs. of Food, during each of the successive Periods, and the Total Period of the Experiment.

Pen Nos.	Description and Quantities of Limited Food per Pig per Day.	Description of Ad Libitum or Complementary Food.	Division I. Average Weekly Consumption of Fresh Food per 100 lbs. Live Weight of Animal.					Division II. Increase obtained by the Consumption of 100 lbs. Fresh Food.					Average Weekly Consumption of Food per 100 lbs. Live Weight of Animal.
			1st Period, 14 days.	2nd Period, 14 days.	3rd Period, 14 days.	4th Period, 14 days.	Total Period, 8 weeks	1st Period, 14 days.	2nd Period, 14 days.	3rd Period, 14 days.	4th Period, 14 days.	Total Period, 8 weeks	
1	None	Bean and lentil meal	31·2	22·9	23·9	22·7	24·9	19·4	17·5	14·4	21·8	18·4	24·9
2	3 lbs. barley-meal	Ditto	43·0	39·6	36·4	31·8	37·0	18·3	12·8	17·8	16·3	16·3	37·0
3	1 lb. bran	Ditto	37·2	34·5	34·6	31·3	34·1	21·1	12·9	17·1	16·6	16·9	34·1
4	3 lbs. barley-meal and 1 lb. bran	Ditto	42·4	33·7	32·9	24·3	33·2	18·4	16·1	18·3	11·7	16·4	33·2
		Means	38·4	32·7	31·9	27·5	32·3	19·3	14·8	16·9	16·6	17·0	32·3
5	None	Barley-meal	39·3	38·1	34·1	28·7	34·6	17·5	18·5	20·7	14·0	17·7	34·6
6	3 lbs. bean and lentil meal	Ditto	40·3	35·2	29·9	17·0	30·9	26·4	13·5	16·1	16·4	18·4	30·9
7	1 lb. bran	Ditto	42·9	36·6	32·1	26·1	34·3	23·1	15·6	13·5	19·2	17·8	34·3
8	3 lbs. bean and lentil meal, and 1 lb. bran	Ditto	40·0	23·5	23·4	20·6	26·8	19·8	13·8	19·8	13·9	17·2	26·8
		Means	40·6	33·3	29·9	23·1	31·6	21·7	15·3	17·5	15·9	17·8	31·6
9	None	Mixture of 1 part bran, 2 parts barley-meal, & 3 parts bean & lentil meal	41·0	37·4	34·1	22·5	33·1	15·9	18·1	18·4	15·8	17·1	33·1
10	None	Duplicate of Pen 9	40·8	38·3	33·7	28·2	35·2	23·7	17·3	14·1	18·0	18·2	35·2
		Means	40·9	37·8	33·9	25·3	34·1	19·8	17·7	16·2	16·9	17·6	34·1
11	None	Mixture of 1 part bran, 2 parts bean & lentil meal, & 3 parts barley-meal	42·7	35·4	31·0	26·3	33·6	24·6	17·9	16·4	20·4	19·9	33·6
12	None	Duplicate of Pen 11	42·8	33·7	34·2	28·5	34·7	26·7	15·3	17·8	19·6	19·9	34·7
		Means	42·7	34·5	32·6	27·4	34·1	25·6	16·6	17·1	20·0	19·9	34·1
		Means of the 12 Pens	40·3	34·1	31·7	25·7	32·7	21·2	15·8	17·0	17·0	17·8	32·7

Table XVI.

(Experiments with Pigs.—Series III)

Showing the Average Weekly Consumption of Food per 100 lbs. Live Weight of Animal—and also the Increase in Weight obtained by the Consumption of every 100 lbs. of Food, during each of the successive Periods, and during the Total Period of the Experiment.

Pen Nos.	Description & Quantities of Limited Food per Pig per Day.	Description of Ad Libitum or Complementary Food.	Division I. Average Weekly Consumption of Fresh Food per 100 lbs. Live Weight of Animal.					Division II. Increase obtained by the Consumption of 100 lbs. Fresh Food.					Average Weekly Consumption of Food per 100 lbs. Live Weight of Animal.
			1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	1st Period, 14 Days.	2nd Period, 14 Days.	3rd Period, 14 Days.	4th Period, 14 Days.	Total Period, 8 Weeks.	
1	2 lbs. cod fish	Bran and Indian-meal (equal parts) .	28·9	30·3	29·7	26·8	28·6	16·4	21·3	17·2	16·1	17·7	28·6
2	2 lbs. cod fish	Indian-meal	29·3	27·7	26·0	23·8	26·1	18·9	24·2	23·2	22·0	22·1	26·1
3	None	Bran and Indian-meal (equal parts), and cod fish.	32·8	33·7	32·1	29·7	32·3	21·7	17·7	12·9	14·1	16·3	32·3
4	1 lb. cod fish	Mixture of 2 parts barley-meal and 1 part bran.	44·7	39·9	33·3	28·8	36·3	19·5	16·1	10·2	21·3	16·7	36·3
5	1 lb. cod fish	Barley-meal	55·2	40·0	33·9	27·5	39·6	23·4	18·8	17·8	11·1	18·2	39·6
		Means of the 5 Pens	38·2	34·3	31·0	27·3	32·6	20·0	19·6	16·3	16·9	18·2	32·6

Looking first to Table XIV. (which refers to Series I.), it is seen, by the heading, that Division I. gives the quantity, in lbs. and tenths, of the gross or fresh food *consumed weekly by every 100 lbs. live-weight of animal* in each pen, during each of the four successive periods, and the total period of the experiment. A glance at the figures in this division from left to right will show, that, with scarcely an exception, there is a very considerable decrease of consumption to 100 lbs. live weight, as the experiment progresses. In several cases there is scarcely half as much food consumed to a given weight of animal in the fourth period as in the first; and, indeed, in all where the progress is known to have been good, this decrease in consumption, from the first period to the fourth, amounts to about one-third or more. On the other hand, it is as clearly seen, that in those cases in which the pigs fattened but very slowly, the decrease in the consumption of food to a given weight of animal, as the experiment proceeded, is very inconsiderable.

Looking at the figures a little more in detail, we observe too, that there is a perceptibly greater decrease in consumption to a given weight of animal, where the comparatively *non*-nitrogenous Indian corn predominated, than where the more highly nitrogenous foods were more freely given.

If we now turn to Divison II. of the Table—which shows the comparative *productiveness* of a given weight of food in gross increase, as the experiment progressed—we see no such obvious general gradation in this, as the animal matured, as has been observed in the rate of the *consumption* of food; though there is perhaps, upon the whole, more of a tendency to decrease than to increase in this rate of productiveness in gross increase, as the experiment proceeded. Comparing, however, the results of pens 1 to 4 inclusive, where the nitrogenous food more predominated, with those of pens 5 to 8, where the Indian meal was given in larger quantity, there is certainly, with the more highly nitrogenous diets, more of the tendency to decrease, in the proportion of gain in live weight to food consumed, than with the more *non*-nitrogenous ones.

Turning to Table XV., which gives the same particulars for the Second Series, we see, that, notwithstanding during the course of the experiment several of the pigs in this Series were unhealthy, and some died, yet the same general facts are here brought out as in Series I. Thus, taking first Division I. (Table XV.), which shows the rate of *consumption* as the animals fattened, we find (owing, doubtless, to the generally better and more uniform balance of the constituents of the food throughout this Series than in Series I.), that the decrease in the consumption of food to 100 lbs. live weight of animal, is even more general in

this series than in the former one. And, the greater tendency to decrease in consumption of food to a given weight of animal, the more within certain limits the comparatively non-nitrogenous food predominates, is here again seen.

In Division II. (Table XV.) we observe, that the rate of *productiveness* in gross increase in weight to 100 lbs. of food consumed, fluctuates so considerably from the commencement to the conclusion of the experiment, but so irregularly, that it is impossible to decide that there is any regular gradation in either direction. There is, indeed, in this case, perhaps more of the tendency to *decrease* in the rate of productiveness of the food in *gross increase* as the experiment proceeded. It is not improbable, however, that the great heat of the weather, and the unhealthiness of some of the pigs, may have had something to do with this result. Though, as we shall have further occasion to observe, a slightly lessened proportion of *gross* increase, to food consumed, does not necessarily show that the food was really less productive in *real dry* increase.

In Division I. of Table XVI., which shows the *rate of consumption*, as the experiment proceeded, with the Third or Cod-fish Series, the influence of the composition of the food on this rate of consumption by the fatting animal, is strikingly shown. Thus, in pens 1 and 2, considerably more of the highly nitrogenous cod-fish was allotted to the pigs than they would have taken, could they have obtained other food in its stead; but, in pens 4 and 5, only half as much of the cod-fish was given, so that the pigs were enabled to take a much larger proportion of the comparatively non-nitrogenous complementary foods. The result is, that with this very much larger proportion of the more *non*-nitrogenous foods in pens 4 and 5, we have in these, a very much greater decrease in the rate of consumption to a given weight of animal than in the pens 1 and 2. There was, indeed, as we shall have occasion to notice again further on, a much less proportion of food consumed to a given weight of animal, when the large amount of the highly nitrogenous cod-fish was given, than in most other cases in our experiments—and, at the same time a full average productiveness in gross increase of that food. But, confining ourselves just now to the question of the proportion of the food consumed to the weight of the animal as it fattens, we find, looking a little more in detail to the figures in Table XVI., that small as was the decrease in consumption in either pens 1 or 2, yet it was greater in pen 2, where the non-nitrogenous Indian meal alone constituted the complementary food, than where, as in pen 1, it was mixed with a quantity of Bran. We have a similar result, more clearly brought out, in comparing pens 4 and 5; the decrease in the rate of consumption to a given weight of animal

as the experiment proceeded, being much greater in pen 5, where Barley-meal was given alone as the ad libitum food, than in pen 4, where it was mixed with Bran.

The progressive rate of *productiveness* of a given weight of food in this Third Series (see Table XVI., Division 2) is very variable, and does not show anything like regularity of gradation. The increase obtained for a given weight of food during the whole period was, however, generally good in this Series. In pen 2 it was about as high as in any case in the three Series; and we may readily suppose, that the mixture of Cod-fish and Indian-meal given in this pen 2, would supply more digestible assimilable matter in a given weight of the food, than that in any other pen in the three Series of experiments.

Upon the whole then, the experiments show very strikingly, the rapid *decrease in the rate of consumption of food to a given weight of animal as it fattens.* The fact of such a decrease is, we believe, pretty currently admitted, though we presume that the extent of it will appear from these Tables to be much greater than is generally supposed. At the same time it is seen, that although there is this great decrease in the amount of food consumed to a given weight of animal as it matures, yet that the *productiveness*—at least in *gross* increase in live weight—of a given amount of food, is much more nearly constant throughout the fattening process. It has, however, been observed, that there is perhaps a greater tendency to an increased rate of productiveness of the food in gross increase as the animal matures, the greater, within certain limits, the proportion of the more *non*-nitrogenous constituents of the food. At any rate it is undoubted, that it was under these circumstances of a larger proportion of the non-nitrogenous constituents, that the decrease in the rate of *consumption—indicating maturity*—was by far the most rapid. And, in reference to this point it may be interesting here to observe, that it appears from an extensive series of experiments which we have made with a view of determining the probable composition of the *gross* increase in weight of the fattening animal, that the nearer it approaches to maturity the greater will be the proportion of *fat* in the gross increase obtained—and also, that the greater the proportion of fat, the greater is the proportion in the gross increase of *real dry substance.* It appears therefore, from the results, that not only is the amount of food, required to a given weight of animal, the more diminished as it fattens—the more within certain limits the food contains of the *non*-nitrogenous constituents—but likewise, that it is these more *non*-nitrogenous foods that seem to give any indication of an increased rate of productiveness in *real dry increase* as the fattening process proceeds.

It will be observed, that in our remarks upon Tables XIV., XV., and XVI., we have almost confined our attention to the

question of the *progressive* rate of the consumption, and of the productiveness, of food during the fattening process—and to the influence which the character of the foods—as generally known apart from the evidence of direct chemical analysis—may be supposed to have had, on this *progression.* The actual relationship of consumption, and of increase, to the various constituents of the food, will be more clearly brought out in Tables which will shortly follow. But, before introducing this part of the subject, it will be well to subjoin statements, both of the per centage composition of the foods employed, and of the actual quantities of the various constituents consumed, with the amounts of increase which they have yielded.

In Tables XVII. and XVIII., which now follow, we have a summary statement of the per centage composition of the foods employed in the three Series of experiments.

Table XVII.

(Experiments with Pigs.—Series I.–III)

Summary of the Percentages of *Dry Matter, Ash, Nitrogen,* and *Fatty Matter,* in the Foods employed in the 1st Series of Experiments with Pigs.

Description.	Percentage Results.							
	Dry Matter.		Ash.		Nitrogen.		Fatty Matter.	
	Inclusive of Ash.	Organic only.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.
Egyptian beans	88·30	83·57	4·73	5·35	4·24	4·80	2·29	2·60
Lentils, Lot 1	87·30	82·43	4·87	5·58	4·52	5·18	2·23	2·55
Lentils, Lot 2	86·62	81·64	4·98	5·75	4·56	5·26	2·21	2·55
Indian corn meal, Lot 1	89·70	88·33	1·37	1·53	1·72	1·92	5·10	5·68
Indian corn meal, Lot 2	89·89	88·62	1·28	1·42	1·95	2·17	5·59	6·22
Bran	84·79	78·77	6·02	7·10	2·61	3·08	4·92	5·80

Table XVIII.

(Experiments with Pigs.—Series II.–III)

Summary of the Percentage Composition of the Foods.

Egyptian Beans	88·17	84·45	3·72	4·22	4·21	4·78	2·20	2·50
Lentils, Lot 1	89·42	86·44	2·98	3·33	4·54	5·08	2·25	2·52
Do. 2	89·97	85·10	4·87	5·41	4·18	4·65	1·35	1·50
Barley, Lot 1	82·38	80·19	2·19	2·66	1·82	2·21	2·34	2·84
Do. 2	80·95	78·77	2·18	2·69	1·83	2·26	2·33	2·88
Do. 3	82·53	80·48	2·05	2·48	1·55	1·88	1·41	1·71
Bran	85·08	78·67	6·41	7·53	2·62	3·08	4·98	5·85
Dried Newfoundland cod-fish	59·26	40·60	18·66	31·49	6·60	11·13	0·90	1·52

The figures in these Tables (XVII. and XVIII.), are in all cases the means of two or more determinations agreeing well with each other. The dry matter is determined by drying in a water-bath at 212°. The ash, by burning on platinum trays, in cast-iron muffles arranged specially for that process. The per-centages of ash, as given in the Table, are, however, generally too high, as, to secure a fair sample, the whole bulk of the food was well mixed together; and, from this, somewhat large samples were taken in the first instance, from which it was impossible to remove all adventitious matters, and especially so when the samples were taken from the bulk in the state of meal. The nitrogen determinations were made by combustion with soda lime, and estimated as the double platinum salt. The fatty matter is that yielded by extraction with ether.

It is seen, that the Indian-corn and Barley-meal contained less than 2 per cent. of nitrogen; the Bran about $2\frac{3}{4}$ per cent; the Beans and Lentils about $4\frac{1}{2}$ per cent.; and the dried Cod-fish about $6\frac{1}{2}$ per cent.

Of fatty matter, on the other hand, the dried Cod-fish contains less than 1 per cent; the Beans and Lentils only about $2\frac{1}{4}$ per cent.; the Barley-meal about the same quantity; and the Indian-corn and Bran, each about 5 per cent.

These Tables of the *per-centage* composition of the foods, are employed in the construction of all the Tables which will now follow.

In Tables XIX., XX., and XXI. there are given, for the three Series respectively,—the total amount of increase in live weight obtained *in each pen;* also the total amounts consumed—of each of the different foods in the fresh state as weighed out to the pigs—and of the dry organic matter—of the mineral matter—of the nitrogen—and of the fatty matter, which those amounts of fresh food contained; also a summary of the same particulars for several of the pens classed together, as well as for all the pens of each Series respectively.

Table XIX.

(Experiments with Pigs.—Series I)

Showing the Total Amounts of Gross Food or Constituents consumed, and of Increase produced, during the Total Period of the Experiment.

Nos. of Pen.	Total Increase of 3 Pigs during 8 Weeks.	Description of the Foods.	Total Fresh Food consumed.	Total Dry Organic Matter consumed.	Total Mineral Matter consumed.	Total Nitrogen consumed.	Total Fatty Matter consumed.
	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
1	303	Bean meal . .	756	632	35·74	32·06	17·36
		Lentil meal . .	756	620	37·34	34·34	16·73
		Total . .	1512	1252	73·08	66·40	34·09
2	336	Indian meal . .	336	297	4·41	6·26	18·16
		Bean meal. . .	624	521	29·48	26·44	14·32
		Lentil meal . .	624	511	30·80	28·34	13·82
		Total . .	1584	1329	64·69	61·04	46·30
3	200	Bran	336	265	20·23	8·77	16·53
		Bean meal. . .	484	404	22·89	20·50	11·1
		Lentil meal . .	484	397	23·82	21·96	10·72
		Total . .	1304	1066	66·94	51·23	38·35
4	252	Indian meal . .	336	297	4·40	6·25	18·16
		Bran	336	265	20·23	8·77	16·52
		Bean meal. . .	378	316	17·88	16·04	8·68
		Lentil meal . .	378	311	18·63	17·17	8·39
		Total . .	1428	1189	61·14	48·23	51·75
5	221	Indian meal . .	1086	961	14·33	20·03	58·23
6	298	Bean meal. . .	168	140	7·93	7·12	3·85
		Lentil meal . .	168	138	8·27	7·61	3·71
		Indian meal . .	1065	942	14·06	19·62	57·05
		Total . .	1401	1220	30·26	34·35	64·61
7	309	Bran	336	265	20·23	8·77	16·53
		Indian meal . .	1063	941	13·94	19·81	57·44
		Total . .	1399	1206	34·17	28·58	73·97
8	347	Bran	336	265	20·23	8·77	16·53
		Bean meal. . .	168	140	7·93	7·12	3·85
		Lentil meal . .	168	138	8·27	7·61	3·71
		Indian meal . .	884	782	11·56	16·55	47·93
		Total . .	1556	1325	47·99	40·05	72·02

TABLE XIX.—EXPERIMENTS WITH PIGS.—SERIES I.—*continued.*

Nos. of Pen.	Total Increase of 3 Pigs during 8 Weeks.	Description of the Foods.	Total Fresh Food consumed.	Total Dry Organic Matter consumed.	Total Mineral Matter consumed.	Total Nitrogen consumed.	Total Fatty Matter consumed.
	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
9	100	Bean meal	231	193	10·91	9·78	5·30
		Lentil meal	231	189	11·39	10·48	5·10
		Bran	431	339	25·95	11·25	21·19
		Total	893	721	48·25	31·51	31·59
10	114	Indian meal	462	409	6·03	8·66	25·10
		Bran	566	446	34·07	14·77	27·83
		Total	1028	855	40·10	23·43	52·93
11	178	Bean meal	168	140	7·93	7·12	3·85
		Lentil meal	168	138	8·27	7·61	3·71
		Indian meal	336	297	4·41	6·25	18·16
		Bran	431	339	25·9	11·25	21·19
		Total	1103	914	46·51	32·23	46·91
12	256	Bean meal	342	286	16·18	14·51	7·85
		Lentil meal	342	282	16·78	15·52	7·60
		Indian meal	616	545	8·07	11·50	33·3
		Bran	71	56	4·27	1·85	3·49
		Total	1371	1169	45·30	43·38	52·24

Summary of Classes of Pens.

Class I. Pens 1-4.	1091	Bran	672	530	40·46	17·54	33·06
		Indian meal	672	594	8·81	12·51	36·32
		Bean meal	2242	1873	105·99	95·04	51·46
		Lentil meal	2242	1839	110·59	101·81	49·66
		Total	5828	4836	265·85	226·90	170·50
Class II. Pens 5-8.	1175	Bran	672	530	40·46	17·54	33·06
		Bean meal	336	280	15·86	14·24	7·70
		Lentil meal	336	276	16·54	15·22	7·42
		Indian meal	4098	3626	53·89	76·01	220·65
		Total	5442	4712	126·75	123·01	268·83
Class III. Pens 9 to 11.	392	Bean meal	399	333	18·84	16·90	9·15
		Lentil meal	399	327	19·66	18·09	8·81
		Indian meal	798	706	10·44	14·91	43·26
		Bran	1428	1124	85·92	37·27	70·21
		Total	3024	2490	134·86	87·17	131·43
All Pens	2914	Bean meal	3319	2772	156·87	140·69	76·16
		Lentil meal	3319	2724	163·57	150·64	73·49
		Indian meal	6184	5471	81·21	114·93	333·53
		Bran	2843	2240	171·11	74·20	139·82
		Total	15,665	13,207	572·76	480·46	623·00

Table XX.

(Experiments with Pigs.—Series II)

Showing the Total Amounts of Gross Food or Constituents consumed, and of Increase produced, during the Total period of the Experiment.

Nos. of Pen.	Total Increase of 3 Pigs during 8 Weeks.	Description of the Foods.	Total Fresh Food consumed.	Total Dry Organic Matter consumed.	Total Mineral Matter consumed.	Total Nitrogen consumed.	Total Fatty Matter consumed.
	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
1	195	Bean meal . .	528	446	19·66	22·25	11·64
		Lentil meal . .	528	453	20·78	22·80	8·93
		Total . .	1056	899	40·44	45·05	20·57
2	284	Bean meal . .	619	523	23·07	26·11	13·65
		Lentil meal . .	619	530	26·39	26·63	10·17
		Barley meal . .	504	400	11·00	9·21	11·76
		Total . .	1742	1453	60·46	61·95	35·58
3	242	Bean meal . .	633	535	23·59	26·70	13·96
		Lentil meal . .	633	542	27·03	27·22	10·36
		Bran	168	132	10·76	4·40	8·36
		Total . .	1434	1209	61·38	58·32	32·68
4	240	Bean meal . .	397	335	14·78	16·73	8·75
		Lentil meal . .	397	340	16·50	17·14	6·71
		Barley meal . .	504	400	11·00	9·21	11·76
		Bran	168	132	10·76	4·40	8·36
		Total . .	1466	1207	53·04	47·48	35·58
5	291	Barley meal . .	1643	1306	35·64	29·50	35·97
		Total . .	1643	1306	35·64	29·50	35·97
6	251	Bean meal . .	231	195	8·60	9·73	5·09
		Lentil meal . .	231	198	9·47	10·00	3·97
		Barley meal . .	907	720	19·80	16·55	21·11
		Total . .	1369	1113	37·87	36·28	30·17

TABLE XX.—(EXPERIMENTS WITH PIGS.—SERIES II)—*continued.*

Nos. of Pen.	Total Increase of 3 Pigs during 8 Weeks.	Description of the Foods.	Total Fresh Food consumed.	Total Dry Organic Matter consumed.	Total Mineral Matter consumed.	Total Nitrogen consumed.	Total Fatty Matter consumed.
	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
7	277	Barley meal . .	1383	1100	29·96	24·77	30·60
		Bran	168	132	10·76	4·40	8·36
		Total . .	1551	1232	40·72	29·17	38·96
8	187	Bean meal . .	189	160	7·04	7·96	4·16
		Lentil meal . .	189	162	7·61	8·20	3·31
		Barley meal . .	600	478	13·03	10·82	13·55
		Bran	126	99	8·07	3·30	6·27
		Total . .	1104	899	35·75	30·28	27·29
9	253	Bean meal . .	369	311	13·73	15·54	8·13
		Lentil meal . .	369	317	13·66	16·06	6·55
		Barley meal . .	492	391	10·70	8·92	11·28
		Bran	246	193	15·76	6·44	12·24
		Total . .	1476	1212	53·85	46·96	38·20
10	283	Bean meal . .	389	329	14·50	16·41	8·58
		Lentil meal . .	389	333	16·13	16·83	6·61
		Barley meal . .	519	413	11·25	9·30	11·49
		Bran	260	204	16·64	6·80	12·92
		Total . .	1557	1279	58·52	49·34	39·60
11	310	Bean meal . .	260	219	9·68	10·95	5·73
		Lentil meal . .	260	222	10·76	11·23	4·41
		Barley meal . .	779	619	16·98	14·16	17·93
		Bran	260	204	16·65	6·81	12·93
		Total . .	1559	1264	54·07	43·15	41·00
12	307	Bean meal . .	257	217	9·56	10·82	5·66
		Lentil meal . .	257	220	10·62	11·10	4·36
		Barley meal . .	770	613	16·70	13·81	17·11
		Bran	257	202	16·46	6·73	12·78
		Total . .	1541	1252	53·34	42·46	39·91

TABLE XX.—(EXPERIMENTS WITH PIGS.—SERIES II)—*continued.*

Summary of Classes of Pens.

Nos. of Pen.	Total Increase of 3 Pigs during 8 Weeks.	Description of the Foods.	Total Fresh Food consumed.	Total Dry Organic Matter consumed.	Total Mineral Matter consumed.	Total Nitrogen consumed.	Total Fatty Matter consumed.
	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
Class I. Pens 1-4	9 61	Bean meal	2177	1839	81·10	91·79	48·00
		Lentil meal	2177	1865	90·70	93·79	36·17
		Barley meal	1008	800	22·00	18·42	23·52
		Bran	336	264	21·52	8·80	16·72
		Total	5698	4768	215·32	212·80	124·41
Class II. Pens 5-8	1006	Bean meal	420	355	15·64	17·69	9·25
		Lentil meal	420	360	17·08	18·20	7·28
		Barley meal	4533	3604	98·43	81·64	101.23
		Bran	294	231	18·83	7·70	14·63
		Total	5667	4550	149·98	125·23	132·39
Class III. Pens 9 & 10.	536	Bean meal	758	640	28·23	31·95	16·71
		Lentil meal	758	650	29·79	32·89	13·16
		Barley meal	1011	804	21·95	18·22	22·77
		Bran	506	397	32·40	13·24	25·16
		Total	3033	2491	112·37	96·30	77·80
Class IV. Pens 11, & 12.	617	Bean meal	517	436	19·24	21·77	11·39
		Lentil meal	517	442	21·38	22·33	8·77
		Barley meal	1549	1232	33·68	27·97	35·04
		Bran	517	406	33·11	13·54	25·71
		Total	3100	2516	107·41	85·61	80·91
All pens	3120	Bean meal	3872	3270	144·21	163·20	85·35
		Lentil meal	3872	3317	158·95	167·21	65·38
		Barley meal	8101	6440	176·06	146·25	182·56
		Bran	1653	1298	105 86	43·28	82·22
		Total	17,498	14,325	585·08	519·94	415·51

TABLE XXI.

(EXPERIMENTS WITH PIGS.—SERIES III)

Showing the Total amounts of Gross Food or Constituents consumed, and of Increase produced, during the Total Period of the Experiment.

No. of Pens.	Total Increase of 4 Pigs during 8 Weeks.	Description of the Foods.	Total Fresh Food consumed.	Total Dry Organic Matter consumed.	Total Mineral Matter consumed.	Total Nitrogen consumed.	Total Fatty Matter consumed.
	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
1	323	Bran	755	595	45·48	19·73	37·15
		Indian meal	755	669	9·84	14·28	41·25
		Cod-fish	308	125	57·50	20·31	2·77
		Total	1818	1389	112·82	54·32	81·17
2	389	Indian meal	1450	1283	18·99	27·14	78·58
		Cod-fish	308	125	57·50	20·31	2·77
		Total	1758	1408	76·49	47·45	81·35
3	286	Bran	756	595	45·51	19·74	37·18
		Indian meal	756	669	9·79	14·29	41·28
		Cod-fish	238	97	44·41	15·70	2·14
		Total	1750	1361	99·71	49·73	80·60
4	301	Barley meal	1048	832	22·82	19·02	24·03
		Bran	524	412	33·58	13·73	26·08
		Cod-fish	224	91	41·79	14·77	2·02
		Total	1796	1335	98·19	47·52	52·13
5	376	Barley meal	1841	1551	40·16	33·54	42·60
		Cod-fish	224	91	41·79	14·77	2·02
		Total	2065	1642	81·95	48·31	44·62

Summary of Classes of Pens.

Class I. Pens 1, 2, & 3.	998	Bran	1511	1190	90·99	39·47	74·33
		Indian meal	2961	2621	38·62	55·71	161·11
		Cod-fish	854	347	159·41	56·32	7·68
		Total	5326	4158	289·02	151·50	243·12
Class II. Pens 4 & 5.	677	Barley meal	2889	2383	62·98	52·56	66·63
		Bran	524	412	33·58	13·73	26·08
		Cod-fish	448	182	83·58	29·54	4·04
		Total	3861	2977	180·14	95·83	96·75
All pens	1675	Bran	2035	1602	124·57	53·20	100·41
		Indian meal	2961	2621	38·62	55·71	161·11
		Barley meal	2889	2383	62·98	52·56	66·63
		Cod-fish	1302	529	242·99	85·86	11·72
		Total	9187	7135	469·16	247·33	339·87

These Tables of the actual amounts of the increase in live weight produced, and of the fresh food or its constituents consumed, furnish a complete account of the chemical statistics of the experiments, and provide a basis for any further calculations; and it is only as serving these purposes, that we have given them in detail in these Tables. We shall find, indeed, that the influence of the composition of the food, upon its consumption, and its productiveness, will be more clearly brought out in the Tables which next follow (XXII., XXIII., XXIV., XXV., XXVI., and XXVII.), in which the actual results of Tables XIX., XX., and XXI. are brought by calculation, to a more convenient and uniform standard of comparison.

We have also endeavoured to arrange some of the more important indications of these six Tables (XXII–XXVII. inclusive), in the form of *Diagrams;* which, with the necessary explanations, will be found at the end of the Paper; and, it is thought, that a careful inspection of them, will materially facilitate a clear conception of the general bearing of the results. A glance even at the Diagrams will show, how very much greater is the variation in the proportion of the *Nitrogenous* constituents, consumed in the different pens by a given weight of animal within a given time, or which is required to produce a given amount of increase, than is that of the *Non*-nitrogenous, or of the Total Organic substance.

TABLE XXII.

(EXPERIMENTS WITH PIGS.—SERIES I)

Division I.—Showing the *Average Weekly Consumption per* 100 lbs. *Live Weight of Animal*—of Fresh Food—of Gross Dry Matter—of Mineral Matter—of Nitrogen—and of Fatty Matter. Results calculated from direct Experimental Determinations. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Fresh Food consumed.			Gross Dry Matter consumed.			Mineral Matter consumed.			Nitrogen consumed.			Fatty Matter consumed.		
				Limited Food.	Ad Libitum Food.	Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	32·0	32·0	–	28·0	28·0	–	1·54	1·54	–	1·40	1·40	–	0·72	0·72
2	3	Indian meal . . .	Ditto	7·1	26·4	33·5	6·4	22·9	29·3	0·09	1·28	1·37	0·13	1·16	1·29	0·38	0·60	0·98
3	3	Bran	Ditto	8·0	23·2	31·2	6·8	20·3	27·1	0·48	1·12	1·60	0·21	1·01	1·22	0·40	0·52	0·92
4	3	Indian meal & bran	Ditto	15·2	17·1	32·3	13·2	15·0	28·2	0·56	0·82	1·38	0·34	0·75	1·09	0·78	0·39	1·17
5	3	None	Indian meal. . .	–	25·1	25·1	–	22·5	22·5	–	0·33	0·33	–	0·46	0·46	–	1·34	1·34
6	3	Bean & lentil meal	Ditto	7·1	22·4	29·5	6·2	20·1	26·3	0·34	0·30	0·64	0·31	0·41	0·72	0·16	1·20	1·36
7	3	Bran	Ditto	7·4	23·3	30·7	6·2	20·9	27·1	0·44	0·31	0·75	0·19	0·43	0·62	0·36	1·16	1·52
8	3	Bean and lentil meal and bran	Ditto	13·9	18·2	32·1	11·9	16·4	28·3	0·75	0·24	0·99	0·48	0·34	0·82	0·50	1·04	1·54
9	3	Bean & lentil meal	Bran	12·1	11·3	23·4	10·6	9·5	20·1	0·58	0·68	1·26	0·53	0·29	0·82	0·27	0·55	0·82
10	3	Indian meal . . .	Ditto	12·2	14·9	27·1	11·0	12·7	23·7	0·16	0·90	1·06	0·23	0·39	0·62	0·66	0·73	1·39
11	3	Bean and lentil meal and Indian meal	Ditto	16·4	10·5	26·9	14·5	8·9	23·4	0·88	0·63	1·51	0·51	0·27	0·78	0·63	0·54	1·17
12	3	None	Bean and lentil meal, Indian meal, and bran, each ad libitum	–	30·8	30·8	–	27·2	27·2	–	1·02	1·02	–	0·97	0·97	–	1·17	1·17
		Mean of the 12 Pens		8·3	21·2	29·5	7·2	18·7	25·9	0·36	0·76	1·12	0·24	0·66	0·90	0·34	0·83	1·17

Table XXII.—*continued.*

(Experiments with Pigs.—Series I)

Division II.—Showing the *Average Weekly Consumption per* 100 lbs. *Live Weight of Animal*—of Dry Organic Matter—of Nitrogenous Substance—of Total *Non*-Nitrogenous Substance—of Non-Nitrogenous Substance not Fat—and of Fatty Matter. Results calculated from Division I. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Dry *Organic* Matter consumed.			Nitrogenous Substance consumed.			Total *Non*-Nitrogenous Substance consumed.			*Non*-Nitrogenous Substance (not fat) consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	26·47	26·47	–	8·84	8·84	–	17·63	17·63	–	16·91	16·91	–	0·72	0·72
2	3	Indian meal . . .	Ditto	6·30	21·65	27·95	0·83	7·30	8·13	5·47	14·35	19·82	5·08	13·75	18·83	0·38	0·60	0·98
3	3	Bran	Ditto	6·34	19·19	25·53	1·32	6·39	7·71	5·01	12·80	17·81	4·62	12·28	16·90	0·40	0·52	0·92
4	3	Indian meal & bran	Ditto	12·70	14·17	26·87	2·14	4·73	6·87	10·56	9·44	20·00	9·78	9·05	18·83	0·78	0·39	1·17
5	3	None	Indian meal . . .	–	22·18	22·18	–	2·91	2·91	–	19·27	19·27	–	17·92	17·92	–	1·34	1·34
6	3	Bean & lentil meal	Ditto	5·85	19·84	25·69	1·95	2·60	4·55	3·90	17·23	21·13	3·74	16·03	19·77	0·16	1·20	1·36
7	3	Bran	Ditto	5·81	20·65	26·46	1·21	2·74	3·95	4·60	17·91	22·51	4·24	16·75	20·98	0·36	1·16	1·52
8	3	{ Bean and lentil meal and bran }	Ditto	11·20	16·15	27·35	3·05	2·15	5·20	8·15	14·00	22·15	7·65	12·96	20·61	0·50	1·04	1·54
9	3	Bean & lentil meal	Bran	10·00	8·88	18·88	3·34	1·85	5·19	6·66	7·03	13·69	6·39	6·47	12·86	0·27	0·55	0·82
10	3	Indian meal . .	Ditto	10·80	11·78	22·58	1·44	2·46	3·90	9·36	9·32	18·68	8·70	8·59	17·29	0·66	0·73	1·39
11	3	{ Bean and lentil meal and Indian meal . . . . }	Ditto	13·66	8·29	21·95	3·23	1·73	4·96	10·44	6·56	17·00	9·81	6·01	15·82	0·63	0·54	1·17
12	3	None	{ Bean and lentil meal, Indian meal, & bran, each ad libitum . }	–	26·23	26·23	–	6·12	6·12	–	20·10	20·10	–	18·93	18·93	–	1·17	1·17
Mean of the 12 Pens				6·89	17·95	24·84	1·54	4·15	5·69	5·35	13·80	19·15	5·00	12·97	17·97	0·34	0·83	1·17

TABLE XXIII.

(EXPERIMENTS WITH PIGS.—SERIES II)

Division I.—Showing the *Average Weekly Consumption per* 100 lbs. *Live Weight of Animal*—of Fresh Food—of Gross Dry Matter—of Mineral Matter—of Nitrogen—and of Fatty Matter. Results calculated from direct Experimental Determinations. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Fresh Food consumed.			Gross Dry Matter consumed.			Mineral Matter consumed.			Nitrogen consumed.			Fatty Matter consumed.		
				Limited Food.	Ad Libitum Food.	Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	24·9	24·9	–	22·2	22·2	–	0·95	0·95	–	1·06	1·06	–	0·48	0·48
2	3	Barley-meal . . .	Ditto	10·7	26·3	37·0	8·7	23·4	32·1	0·22	1·05	1·27	0·20	1·12	1·32	0·25	0·51	0·76
3	3	Bran	Ditto	4·0	30·1	34·1	3·4	26·8	30·2	0·26	1·20	1·46	0·10	1·28	1·38	0·20	0·58	0·78
4	3	Barley-meal & bran	Ditto	15·2	18·0	33·2	12·6	16·0	28·6	0·49	0·71	1·20	0·31	0·77	1·08	0·46	0·35	0·81
5	3	None	Barley-meal . . .	–	34·6	34·6	–	28·3	28·3	–	0·75	0·75	–	0·62	0·62	–	0·76	0·76
6	3	Bean & lentil meal	Ditto	10·4	20·5	30·9	9·3	16·7	26·0	0·41	0·45	0·86	0·45	0·37	0·82	0·20	0·48	0·68
7	3	Bran	Ditto	3·7	30·6	34·3	3·2	25·0	28·2	0·24	0·66	0·90	0·10	0·55	0·65	0·18	0·68	0·86
8	3	{Bean and lentil meal and bran}	Ditto . . .	12·3	14·6	26·9	10·8	11·9	22·7	0·55	0·32	0·87	0·47	0·26	0·73	0·33	0·33	0·66
9	3	None	{Mixture of 1 part bran, 2 parts barley-meal, and 3 parts bean and lentil meal.}	–	33·1	33·1	–	28·4	28·4	–	1·21	1·21	–	1·05	1·05	–	0·86	0·86
10	3	None	Duplicate of Pen 9	–	35·2	35·2	–	30·3	30·3	–	1·32	1·32	–	1·12	1·12	–	0·90	0·90
11	3	None	{Mixture of 1 part bran, 2 parts bean and lentil meal, and 3 parts barley-meal.}	–	33·6	33·6	–	28·4	28·4	–	1·16	1·16	–	0·93	0·93	–	0·88	0·88
12	3	None	Duplicate of Pen 11	–	34·7	34·7	–	29·4	29·4	–	1·20	1·20	–	0·95	0·95	–	0·90	0·90
Mean of the 12 Pens				4·7	28·0	32·7	4·0	23·9	27·9	0·18	0·91	1·09	0·13	0·84	0·97	0·13	0·64	0·77

Table XXIII.—*continued.*

(Experiments with Pigs.—Series II)

Division II.—Showing the *Average Weekly Consumption per* 100 lbs. *Live Weight of Animal*—of Dry Organic Matter—of Nitrogenous Substance—of Total *Non*-Nitrogenous Substance—of Non-Nitrogenous Substance not Fat—and of Fatty Matter. Results calculated from Division I. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Dry *Organic* Matter consumed.			Nitrogenous Substance consumed.			Total *Non*-Nitrogenous Substance consumed.			*Non*-Nitrogenous Substance (not Fat) consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	21·21	21·21	–	6·69	6·69	–	14·51	14·51	–	14·03	14·03	–	0·48	0·48
2	3	Barley-meal . . .	Ditto	8·51	22·39	30·90	1·23	7·06	8·29	7·28	15·33	22·61	7·03	14·82	21·85	0·25	0·51	0·76
3	3	Bran	Ditto	3·14	25·59	28·73	0 66	8·07	8·73	2·48	17·52	20·00	2·28	16·94	19·22	0·20	0·58	0·78
4	3	Barley-meal & bran	Ditto	12·07	15·31	27·38	1·95	4·85	6·80	10·12	10·46	20·58	9·66	10·11	19·17	0·46	0·35	0·81
5	3	None	Barley-meal . . .	–	27·51	27·51	–	3·91	3·91	–	23·60	23·60	–	22·84	22·84	–	0·76	0·76
6	3	Bean & lentil meal	Ditto	8·87	16·26	25·13	2·81	2·36	5·17	6·06	13·91	19·97	5·86	13·43	19·29	0·20	0·48	0·68
7	3	Bran	Ditto	2·92	24·36	27·28	0·61	3·45	4·06	2·31	20·90	23·21	2·13	20·22	22·35	0·18	0·68	0·86
8	3	Bean and lentil meal and bran	Ditto	10·23	11·62	21·85	2·98	1·66	4·64	7·25	9·97	17·22	6·92	9·64	16·56	0·33	0·33	0·66
9	3	None	Mixture of 1 part bran, 2 parts barley-meal, and 3 parts bean and lentil meal.	–	27·24	27·24	–	6·65	6·65	–	20·59	20·59	–	19·73	19·73	–	0·86	0·86
10	3	None	Duplicate of Pen 9	–	28·96	28·96	–	7·03	7·03	–	21·92	21·92	–	21·02	21·02	–	0·90	0·90
11	3	None	Mixture of 1 part bran, 2 parts bean and lentil meal, and 3 parts barley-meal.	–	27·26	27·26	–	5·86	5·86	–	21·41	21·41	–	20·53	20·53	–	0·88	0·88
12	3	None	Duplicate of Pen 11	–	28·17	28·17	–	6·02	6·02	–	22·15	22·15	–	21·25	21·25	–	0·90	0·90
		Mean of the 12 Pens		3·81	22·99	26·80	0·85	5·30	6·15	2·96	17·69	20·65	2·82	17·05	19·87	1·13	0·64	0·77

Table XXIV.

(Experiments with Pigs.—Series III)

Division I.—Showing the *Average Weekly Consumption per* 100 lbs. *Live Weight of Animal*—of Fresh Food—of Gross Dry Matter—of Mineral Matter—of Nitrogen—and of Fatty Matter. Results calculated from direct Experimental Determinations. (Quantities stated in lbs., tenths, &c.)

Pen.	Pigs.	Description of Limited Food.	Description of Ad Libitum Food.	Fresh Food consumed.			Gross Dry Matter consumed.			Mineral Matter consumed.			Nitrogen consumed.			Fatty Matter consumed.		
				Limited Food.	Ad Libitum Food.	Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	4	Cod-fish .	Bran & Indian meal (equal parts) . . .	4·8	23·8	28·6	2·9	20·8	23·7	0·91	0·87	1·78	0·32	0·54	0·86	0·04	1·23	1·27
2	4	Ditto . .	Indian meal . .	4·6	21·5	26·1	2·7	19·4	22·1	0·85	0·28	1·13	0·30	0·40	0·70	0·04	1·17	1·21
3	4	None . .	Cod-fish . . .	–	4·4	32·3	–	2·6	27·0	–	0·82	1·84	–	0·29	0·92	–	0·04	1·49
			Bran & Indian meal (equal parts) . . .	–	27·9		–	24·4		–	1·02		–	0·63		–	1·45	
			Means	3·1	25·9	29·0	1·9	22·4	24·3	0·59	0·99	1·58	0·21	0·62	0·83	0·03	1·29	1·32
4	4	Cod-fish .	Mixture of 2 parts barley-meal, and 1 part bran . .	4·5	31·7	36·2	2·7	26·2	28·9	0·84	1·14	1·98	0·30	0·66	0·96	0·04	1·01	1·05
5	4	Ditto . .	Barley-meal . .	4·3	35·3	39·6	2·5	30·5	33·0	0·80	0·77	1·57	0·28	0·64	0·92	0·04	0·82	0·86
			Means	4·4	33·5	37·9	2·6	28·4	31·0	0·82	0·95	1·77	0·29	0·65	0·94	0·04	0·91	0·95
		Means of the 5 Pens		3·6	29·0	32·6	2·2	24·8	27·0	0·68	0·98	1·66	0·24	0·63	0·87	0·03	1·14	1·17

TABLE XXIV.—*continued.*

(EXPERIMENTS WITH PIGS.—SERIES III)

Division II.—Showing the *Average Weekly Consumption per* 100 lbs. *Live Weight of Animal*—of Dry Organic Matter—of Nitrogenous Substance—of Total *Non*-Nitrogenous Substance—of Non-Nitrogenous Substance not Fat—and of Fatty Matter. Results calculated from Division I. (Quantities stated in lbs., tenths, &c.)

Pen.	Pigs.	Description of Limited Food.	Description of Ad Libitum Food.	Dry Organic Matter consumed.			Nitrogenous Substance consumed.			Total *Non*-Nitrogenous Substance consumed.			*Non*-Nitrogenous Substance (not fat) consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	4	Cod-fish .	Bran & Indian meal (equal parts) . .	1·97	19·91	21·88	1·92	3·38	5·30	0·04	16·54	16·58	0·00	15·30	15·30	0·04	1·23	1·27
2	4	Ditto . .	Indian meal . .	1·86	19·08	20·94	1·82	2·54	4·36	0·04	16·54	16·58	0·00	15·37	15·37	0·04	1·17	1·21
			Cod-fish . .	–	1·79		–	1·75		–	0·04		–	0·00		–	0·04	
3	4	None . .	Bran & Indian meal (equal parts) . . .	–	23·39	25·18	–	3·96	5·71	–	19·43	19·47	–	17·97	17·97	–	1·45	1·49
			Means . . .	1·28	21·39	22·67	1·25	3·88	5·13	0·03	17·52	17·55	0·00	16·21	16·21	0·03	1·29	1·32
4	4	Cod-fish .	Mixture of 2 parts barley-meal, and 1 part bran . .	1·86	25·06	26·92	1·80	4·16	5·95	0·06	20·90	20·96	0·02	19·89	19·91	0·04	1·01	1·05
5	4	Ditto . .	Barley-meal . .	1·70	29·73	31·43	1·71	4·05	5·76	0·04	25·68	25·72	0·00	24·86	24·86	0·04	0·82	0·86
			Means	1·78	27·46	29·17	1·75	4·11	5·86	0·05	23·29	23·31	0·00	22·37	22·37	0·04	0·91	0·95
		Means of the 5 Pens . . .		1·48	23·79	25·27	1·45	3·97	5·42	0·04	19·82	19·86	0·004	18·68	18·68	0·03	1·14	1·17

TABLE XXV.

(EXPERIMENTS WITH PIGS.—SERIES I.)

Division I.—Showing the Average Consumption to *produce* 100 lbs. *Increase in Live Weight*—of Fresh Food—of Gross Dry Matter—of Mineral Matter—of Nitrogen—and of Fatty Matter. Results calculated from direct Experimental Determinations. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Fresh Food consumed.			Gross Dry Matter consumed.			Mineral Matter consumed.			Nitrogen consumed.			Fatty Matter consumed.		
				Limited Food.	Ad Libitum Food.	Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	499	499	–	437	437	–	24·12	24·12	–	21·91	21·91	–	11·25	11·25
2	3	Indian meal . . .	Ditto	100	371	471	90	322	412	1·31	19·93	19·24	1·86	16·28	18·14	5·41	8·37	13·78
3	3	Bran	Ditto	168	484	652	142	424	566	10·09	23·31	33·40	4·38	21·20	25·58	8·26	10·91	19·17
4	3	Indian meal & bran	Ditto	267	300	567	233	263	496	7·75	14·48	24·23	5·96	13·18	19·14	13·76	6·77	20·53
5	3	None	Indian meal . . .	–	491	491	–	441	441	–	6·48	6·48	–	9·06	9·06	–	26·35	26·35
6	3	Bean & lentil meal	Ditto	113	357	470	99	321	420	5·44	4·72	10·16	4·94	6·58	11·52	2·54	19·14	21·68
7	3	Bran	Ditto	109	344	453	92	309	401	6·53	4·51	11·04	2·84	6·41	9·25	5·35	17·15	22·50
8	3	Bean and lentil meal, and bran	Ditto	194	255	449	167	229	396	10·48	3·33	13·81	6·77	4·77	11·54	6·94	14·48	21·42
9	3	Bean & lentil meal	Bran	462	431	893	405	365	770	22·20	25·90	48·10	20·26	11·25	31·51	10·40	21·19	31·59
10	3	Indian meal . . .	Ditto	405	496	901	364	421	785	5·29	29·90	35·19	7·60	12·96	20·56	2·20	24·41	26·61
11	3	Bean and lentil meal, and Indian meal	Ditto	377	242	619	335	205	540	20·31	14·55	34·86	11·79	6·32	18·11	14·44	11·90	26·34
12	3	None	Bean and lentil meal, Indian meal and bran, each ad libitum . . .	–	536	536	–	474	474	–	17·72	17·72	–	16·93	16·93	–	20·40	20·40
Mean of the 12 Pens				183	400	583	160	351	511	7·62	15·58	23·20	5·53	12·24	17·77	5·77	16·03	21·80

TABLE XXV.—*continued.*

(EXPERIMENTS WITH PIGS.—SERIES I)

Division II.—Showing the Average Consumption to *produce* 100 lbs. *Increase in Live Weight*—of Dry Organic Matter—of Nitrogenous Substance—of Total *Non*-Nitrogenous Substance—of Non-Nitrogenous Substance (not Fat)—and of Fatty Matter. Results calculated from Division I. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Dry Organic Matter consumed.			Nitrogenous Substance consumed.			Total *Non*-Nitrogenous Matter consumed.			*Non*-Nitrogenous Matter (not fat) consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	413·3	413·3	–	138·0	138·0	–	275·3	275·3	–	264·0	264·0	–	11·25	11·25
2	3	Indian meal . . .	Ditto	88·5	304·1	392·6	11·7	102·6	114·3	76·8	201·5	278·3	71·4	193·2	264·6	5·41	8·37	13·78
3	3	Bran	Ditto	132·3	400·7	533·0	27·6	133·6	161·2	104·7	267·1	371·8	96·5	256·2	252·7	8·26	10·91	19·17
4	3	Indian meal & bran	Ditto	222·9	248·7	471·6	37·5	83·0	120·5	185·4	165·7	351·1	171·6	158·9	330·5	13·76	6·77	20·53
5	3	None	Indian meal . . .	–	434·8	434·8	–	57·1	57·1	–	377·7	377·7	–	351·4	351·4	–	26·35	26·35
6	3	Bean & lentil meal	Ditto	93·3	316·2	409·5	31·1	41·4	72·5	62·2	274·7	336·9	59·7	255·6	315·3	2·54	19·14	21·68
7	3	Bran	Ditto	85·6	304·5	390·1	17·9	40·4	58·3	67·7	264·1	331·8	62·4	247·0	309·4	5·35	17·15	22·50
8	3	Bean and lentil meal, and bran	Ditto	156·4	225·5	381·9	42·6	30·0	72·6	113·8	195·4	309·2	106·8	181·0	287·8	6·94	14·48	21·42
9	3	Bean & lentil meal	Bran	382·4	339·5	721·9	127·6	70·9	198·5	254·8	268·6	523·4	244·4	247·4	491·8	10·40	21·19	31·59
10	3	Indian meal . . .	Ditto . . .	358·6	391·0	749·6	47·9	81·6	129·5	310·7	309·4	620·1	308·5	274·9	583·4	2·20	24·41	26·61
11	3	Bean and lentil meal, and Indian meal	Ditto	314·5	190·7	505·2	74·3	39·8	114·1	240·2	150·9	391·1	252·8	139·0	391·8	14·44	11·90	26·34
12	3	None	Bean and lentil meal, Indian meal and bran, each ad libitum	–	456·5	456·5	–	106·7	106·7	–	349·8	349·8	–	329·4	329·4	–	20·40	20·40
		Mean of the 12 Pens		152·9	335·4	488·3	34·8	77·1	111·9	118·0	258·3	376·3	114·5	241·5	356·0	5·77	16·03	21·80

TABLE XXVI.

(EXPERIMENTS WITH PIGS.—SERIES II)

Division I.—Showing the Average Consumption to *produce* 100 lbs. *Increase in Live Weight*—of Fresh Food—of Gross Dry Matter—of Mineral Matter—of Nitrogen—and of Fatty Matter. Results calculated from direct Experimental Determinations. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Fresh Food consumed.			Gross Dry Matter consumed.			Mineral Matter consumed.			Nitrogen consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	544	544	–	484	484	–	20·84	20·84	–	23·22	23·22	–	10·55	10·55
2	3	Barley-meal . . .	Ditto	177	436	613	145	388	533	3·87	17·39	21·26	3·24	18·57	21·81	4·14	8·39	12·53
3	3	Bran	Ditto	69	523	592	59	466	525	4·45	20·92	25·37	1·82	22·28	24·10	3·45	10·05	13·50
4	3	Barley-meal & bran	Ditto	280	331	611	231	294	525	9·07	13·03	22·10	5·67	14·11	19·78	8·38	6·44	14·82
5	3	None	Barley-meal . . .	–	565	565	–	461	461	–	12·25	12·25	–	10·14	10·14	–	12·36	12·36
6	3	Bean & lentil meal	Ditto	184	361	545	164	295	459	7·20	7·89	15·09	7·87	6·59	14·46	3·61	8·41	12·02
7	3	Bran	Ditto	61	499	560	52	408	460	3·88	10·82	14·70	1·59	8·94	10·53	3·02	11·05	14·07
8	3	Bean and lentil meal and bran	Ditto	265	316	581	233	258	491	11·96	6·86	18·82	10·24	5·69	15·93	7·35	7·25	14·60
9	3	None	Mixture of 1 part bran, 2 parts barley-meal, and 3 parts bean and lentil meal.	–	583	583	–	501	501	–	21·28	21·28	–	18·56	18·56	–	15·10	15·10
10	3	None	Duplicate of Pen 9	–	550	550	–	473	473	–	20·68	20·68	–	17·42	17·42	–	14·00	14·00
11	3	None	Mixture of 1 part bran, 2 parts bean and lentil meal, and 3 parts barley-meal.	–	503	503	–	425	425	–	17·44	17·44	–	13·92	13·92	–	13·22	13·22
12	3	None	Duplicate of Pen 11	–	502	502	–	425	425	–	17·37	17·37	–	13·83	13·83	–	13·00	13·00
		Mean of the 12 Pens		86	476	562	74	406	480	3·37	15·56	18·93	2·54	14·44	16·98	2·49	10·82	13·31

TABLE XXVI.—*continued.*

(EXPERIMENTS WITH PIGS.—SERIES II)

Division II.—Showing the Average Consumption to *produce* 100 lbs. *Increase in Live Weight*—of Dry Organic Matter—of Nitrogenous Substance—of Total *Non*-Nitrogenous Substance—of Non-Nitrogenous Substance (not Fat)—and of Fatty Matter. Results calculated from Division I. (Quantities stated in lbs., tenths, &c.)

Pen	Pigs	Description of Limited Food.	Description of Ad Libitum Food.	Dry *Organic* Matter consumed.			Nitrogenous Substance consumed.			Total *Non*-Nitrogenous Substance consumed.			*Non*-Nitrogenous Substance (not Fat) consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	3	None	Bean & lentil meal	–	463·5	463·5	–	146·3	146·3	–	317·2	317·2	–	306·6	306·6	–	10·55	10·55
2	3	Barley-meal . . .	Ditto	140·7	370·8	511·5	20·4	117·0	137·4	120·3	253·8	374·1	116·2	245·4	361·6	4·14	8·39	12·53
3	3	Bran	Ditto	54·7	445·0	499·7	11·5	140·4	151·9	43·3	304·6	347·9	39·8	294·6	334·4	3·45	10·05	13·50
4	3	Barley-meal & bran	Ditto	221·6	281·3	502·9	35·7	88·9	124·6	185·9	192·4	378·3	177·5	186·0	363·5	8·38	6·44	14·82
5	3	None	Barley-meal . . .	–	448·8	448·8	–	63·9	63·9	–	384·9	384·9	–	372·5	372·5	–	12·36	12·36
6	3	Bean & lentil meal	Ditto	156·5	286·9	443·4	49·6	41·5	91·1	106·9	245·4	352·3	103·3	237·0	340·3	3·61	8·41	12·02
7	3	Bran	Ditto	47·7	397·0	444·7	10·0	56·3	66·3	37·7	340·7	378·4	34·7	329·6	364·3	3·02	11·05	14·07
8	3	{Bean and lentil meal and bran}	Ditto	221·4	251·4	472·8	64·5	35·8	100·3	156·9	215·6	372·5	149·6	208·3	357·9	7·35	7·25	14·60
9	3	None	{Mixture of 1 part bran, 2 parts barley meal, and 3 parts bean and lentil meal.}	–	479·4	479·4	–	116·9	116·9	–	362·5	362·5	–	347·4	347·4	–	15·10	15·10
10	3	None	Duplicate of Pen 9	–	452·2	452·2	–	109·7	109·7	–	342·5	342·5	–	348·5	348·5	–	14·00	14·00
11	3	None	{Mixture of 1 part bran, 2 parts bean and lentil meal, and 3 parts barley-meal.}	–	408·1	408·1	–	87·7	87·7	–	320·4	320·4	–	307·2	307·2	–	13·22	13·22
12	3	None	Duplicate of Pen 11	–	407·7	407·7	–	87·1	87·1	–	320·6	320·6	–	307·6	307·6	–	13·00	13·00
		Mean of the 12 Pens		70·2	391·0	461·2	16·0	90·9	90·9	54·2	301·7	355·9	51·7	290·9	342·6	2·49	10·82	13·31

Table XXVII.

(Experiments with Pigs.—Series III)

Division I.—Showing the Average Consumption to *produce* 100 lbs. *Increase in Live Weight*—of Fresh Food—of Gross Dry Matter—of Mineral Matter—of Nitrogen—and of Fatty Matter. Results calculated from direct Experimental Determinations. (Quantities stated in lbs., tenths, &c.)

Pen.	Pigs.	Description of Limited Food.	Description of Ad Libitum Food.	Fresh Food consumed.			Gross Dry Matter consumed.			Mineral Matter consumed.			Nitrogen consumed.			Fatty Matter consumed.		
				Limited Food.	Ad Libitum Food.	Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	4	Cod-fish .	Bran & Indian meal (equal parts) . . .	95	468	563	56	408	464	17·80	17·12	34·92	6·29	10·53	16·82	0·86	24·27	25·13
2	4	Ditto . .	Indian meal . .	79	373	452	47	335	382	14·78	4·88	19·66	5·22	6·98	12·20	0·71	20·20	20·91
3	4	None . .	Cod-fish . . .	–	83	612	–	49	511	–	15·53	34·87	–	5·49	17·39	–	0·75	28·18
			Bran & Indian meal (equal parts) . . .	–	529		–	462		–	19·34		–	11·90		–	27·43	
			Means . . .	58	484	542	34	418	452	10·86	18·96	29·82	3·84	11·63	15·47	0·52	24·22	24·74
4	4	Cod-fish .	Mixture of 2 parts barley-meal, & 1 part bran . .	74	522	596	44	432	476	13·88	18·74	32·62	4·91	10·88	15·79	0·67	16·65	17·32
5	4	Ditto . .	Barley-meal . .	59	490	549	35	423	458	11·11	10·68	21·79	3·93	8·92	12·85	0·54	11·33	11·87
			Means . . .	66	506	572	40	427	467	12·49	14·71	27·20	4·42	9·90	14·32	0·60	13·99	14·59
			Means of the 5 Pens . .	61	493	554	36	422	458	11·51	17·26	28·77	4·07	10·94	15·01	0·56	20·12	20·68

Table XXVII.—*continued.*

(Experiments with Pigs.—Series III)

Division II.—Showing the Average Consumption to *produce* 100 lbs. *Increase in Live Weight*—of Dry Organic Matter—of Nitrogenous Substance—of Total *Non*-Nitrogenous Substance—of Non-Nitrogenous Substance (not Fat)—and of Fatty Matter. Results calculated from Division I. (Quantities stated in lbs., tenths, &c.)

Pen.	Pigs.	Description of Limited Food.	Description of Ad Libitum Food.	Dry Organic Matter consumed.			Nitrogenous Substance consumed.			Total *Non*-Nitrogenous Matter consumed.			*Non*-Nitrogenous Matter (not fat) consumed.			Fatty Matter consumed.		
				In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.	In Limited Food.	In Ad Libitum Food.	In Total Food.
1	4	Cod-fish .	Bran & Indian meal (equal parts) . . .	38·7	391·4	430·1	37·8	66·3	104·1	0·9	325·1	326·0	0·0	300·8	300·8	0·86	24·27	25·13
2	4	Ditto . .	Indian meal . .	32·1	329·9	362·0	31·4	41·0	75·4	0·7	285·9	286·6	0·0	265·7	265·7	0·71	20·20	20·91
3	4	None . .	Cod-fish . . .	–	33·8	476·1	–	33·0	108·0	–	0·7	368·0	–	0·0	339·9	–	0·75	28·18
			Bran & Indian meal (equal parts) . . .	–	442·3		–	75·0		–	367·3		–	339·9		–	27·43	
			Means . . .	23·6	399·1	422·7	23·0	72·8	95·8	0·5	326·3	326·8	0·0	302·1	302·1	0·52	24·22	24·74
4	4	Cod-fish .	Mixture of 2 parts barley-meal, & 1 part bran . .	30·2	413·4	443·6	29·5	68·5	98·0	0·7	344·9	345·6	0·0	328·2	328·2	0·67	16·65	17·32
5	4	Ditto . .	Barley-meal . .	24·2	412·4	436·6	23·6	56·2	79·8	0·6	356·2	356·8	0·0	344·9	344·9	0·54	11·33	11·87
			Means . . .	27·2	412·9	440·1	26·5	62·4	88·9	0·6	350·5	351·1	0·0	336·5	336·5	0·60	13·99	14·59
			Means of the 5 Pens. .	25·0	404·7	429·7	24·5	68·6	93·1	0·6	336·0	336·6	0·0	315·9	315·9	0·56	20·12	20·68

In Tables XXII., XXIII., XXIV., XXV., XXVI., and XXVII., we have then, for each Series, the actual facts of Tables XIX., XX., and XXI., reduced by calculation to one uniform standard of comparison. That is to say, we have in Tables XXII., XXIII., and XXIV.,* for the three Series respectively, the amounts of the fresh food, and of its various constituents, consumed *weekly per* 100 *lbs. live weight of animal* in each pen, instead of, as in the previous ones, the *actual quantity* of food, or of its constituents, consumed *per pen during the whole course of the experiment.* And again, we have, in Tables XXV., XXVI., and XXVII.,† the amounts of the foods, or their constituents, consumed *to produce* 100 *lbs. increase in live weight,* instead of, the *actual amounts* consumed, *to produce the actual amount of increase obtained per pen.* We have in previous papers, when adopting these methods of representing the results of feeding experiments, explained the general principle upon which such Tables are calculated, and we shall not therefore repeat those explanations here. We may, however, a little further describe the plan of the Tables as they stand—as well as the materials whence some of their contents have been derived.

It will be seen, that each of the six Tables, whether relating to the amounts of food, &c., consumed weekly per 100 lbs. live weight of animal, or the amounts consumed to produce 100 lbs. gross increase in weight, is divided into two "Divisions." *Division* 1, in every case, gives what may be called the results of direct experiment—that is to say, the amounts of fresh food consumed, or of those constituents which are calculated directly from the quantities of the latter and the Tables of their per-centage composition, as determined by actual analysis. The constituents given in this Division 1, are—the *Fresh food*, the *Gross dry matter*, the *Mineral matter*, the *Nitrogen*, and the *Fatty matter*. In Division 2, we have—the *Dry organic matter*, the *Nitrogenous substance*, the *Total non-nitrogenous substance*, the *Non-nitrogenous substance not Fat*, and with these (which, as will be readily understood, are derived by calculation from those in Division 1), the *Fatty matter* is repeated in this Division, for the convenience of comparison with them. The dry organic matter, is obtained by deducting the mineral matter from the gross dry substance—the nitrogenous substance, by multiplying the nitrogen by 6·3, on the assumption that it existed in the foods as protein compounds—a method which we think sufficiently accurate for our present purpose. The total non-nitrogenous substance, is obtained by deducting the nitrogenous substance from the dry organic matter—and the non-nitrogenous substance not fat, by deducting the fatty matter from the total non-nitrogenous substance.

* See also Diagram I. † See also Diagram II.

Before considering the results themselves given in these Tables, it may be as well to say a few words on some of the questions of interest upon which, we think, they are calculated to afford some useful information.

Our readers are aware, that much attention has of late years been paid to the subject of the adaptation of food, according to its composition, to the various exigencies of the animal system. And, it will be admitted, that it is to the experiments and writings of MM. Boussingault, Liebig, and Dumas, that we must attribute, either directly or indirectly, much of the progress that has been made. These writers, as well as many others, whether themselves experimenters, or more systematic writers on the subject of the Chemistry of Food, seem with few exceptions, and with some limitations, to agree on two main points, namely—as to the relationship of the *nitrogenous* constituents of food, with the formation in the animal body of compounds containing nitrogen—and as to the general connection of the non-nitrogenous constituents with respiration and the deposition of animal fat. Founded more or less upon this broad classification of the constituents of food, according to their supposed varied offices in the animal economy, a vast number of analyses of foods have of late years been made; and from the results of these analyses, numerous Tables have been constructed, professing to arrange the current articles of diet, both of man and other animals, according to their comparative values as such. In attempting to apply to practice the more generally admitted facts to which we have referred, in the construction of Tables of the comparative values of foods according to their composition, it seems to have been generally assumed, that our current food-stuffs are thus measurable rather by their *flesh-forming* than by their more specially *respiratory* and *fat-forming* capacities. Hence, with some limitations, the percentage of nitrogen has always been taken as the standard of comparison.

Founded on their per-centages of nitrogen, M. Boussingault first arranged Tables of the comparative value of different articles of food, chiefly in reference to the dieting of the animals of the farm. And, in reference to the views and experiments of M. Boussingault on this subject, Baron Liebig, at p. 369 of the Third Edition of his Chemical Letters, makes the following observations:—"The admirable experiments of Boussingault prove, that the increase in the weight of the body in the fattening or feeding of stock (just as is the case with the supply of milk obtained from milch cows), is in proportion to the amount of plastic constituents in the daily supply of fodder." In like manner various specimens of flour and of bread have been arranged by Dr. R. D. Thomson; other articles of vegetable diet by Mr. Horsford; and a large series of aliments from the animal kingdom by MM. Schlossberger and Kemp. Dr. Anderson also,

in the Report of his elaborate investigation, on the Composition of Turnips, grown under different circumstances, and in different localities, has taken their per-centage of Nitrogen as the measure of their comparative feeding values.

It has been found, however, that the indications of Tables of the comparative values of foods, founded upon their per-centages of nitrogenous compounds, were frequently discrepant with those which common usage, or direct experiments on feeding, seem to give. These discrepancies have not escaped the attention of some of the authors of the theoretical Tables ; but they have attributed them, rather to erroneous interpretations of common practice or experiment, than to any defect in the theoretical method of estimation. It has been admitted on all hands, however, that further direct experiment bearing upon this important question was much needed; and it was the acknowledgment of this necessity, and the fact that the further we proceeded with our own investigations, the more we became convinced that the current views on the subject required some modification—that led us to give a paper, "On the Composition of Food in relation to Respiration and the Feeding of Animals," at the meeting of the British Association held last year at Belfast. That paper is now in print, as a "Report" in the annual volume of the Association. But, as in that medium it will probably come under the notice of few but scientific readers, we have been induced, in compliance with a wish expressed by Mr. Pusey, as the editor of this Journal, to embody in this article, so far as these experiments on Pigs illustrate them, some of the views of that paper, which may be of interest more particularly in their agricultural bearings.

Recurring to the question of the adopted views on the subject of the Chemistry of Food, to which we have called attention, we may observe, that in our paper on Sheep Feeding, in vol. 10, part 1, of this Journal, we ourselves had, to a certain extent, adopted the current opinion that the increase in weight in the fattening animal will bear a pretty direct relationship to the supply in the food of the nitrogenous or plastic elements of nutrition. At that time, however, we observed in our results, some marked exceptions to this rule ; and we pointed out, that it seemed to apply only so long as the nitrogenous supplies in the food did not exceed a somewhat narrow limit, frequently reached in our current fattening food-stuffs—and beyond which, the proportion of increase obtained from a given amount of nitrogenous substance consumed seemed to be considerably diminished. In that paper, we also showed, that the amount of food consumed to a given weight of animal, within a given time, bore in the experiments then brought forward, a much closer relationship to the amounts in the food of the available non-nitrogenous constituents,

than to those of the nitrogenous ones. The results of the experiments with Pigs, as given in the six Tables now about to be considered, will be found fully to bear out the same conclusions which those on Sheep seemed to indicate—namely, that, as our current fattening food-stuffs go, both the amount consumed by a given weight of animal, within a given time, and that required to produce a given amount of increase, bear a much closer relationship to the amounts in the food, of the available *non-nitrogenons* constituents, than to those of the nitrogenous ones.

Turning now to the Tables themselves (XXII., XXIII., XXIV., XXV., XXVI., and XXVII.), we shall find, that the columns of total dry organic matter, of nitrogenous substance, and of total non-nitrogenous substance, as given in Division 2 of each of them, will illustrate the points in question. A glance at the total columns for these three classes of constituents, throughout the Tables for the three Series as a whole, will show, that in all comparable cases, there is very much more of uniformity, in the columns of the *total organic matter*, or of the *total non-nitrogenous* substance, than in those of the *nitrogenous* substance—both in Tables XXII, XXIII., and XXIV., which give the amounts consumed *weekly per* 100 *lbs. live weight of animal*, and in Tables XXV., XXVI., and XXVII., which give the amounts consumed *to produce* 100 *lbs. of increase.**

Some of the deviations from this general regularity in the amounts of non-nitrogenous, or of total organic substance consumed, clearly show when examined into, that the uniformity would be even more strict, if the amounts, only of the really digestible or available respiratory and fat-forming constituents could have been represented, instead of, as in these Tables, that of the *gross* or *total* organic or non-nitrogenous substance consumed; and this is more particularly the case in those Tables which show the amount consumed to produce a given weight of increase.

Thus, in reading the figures of the Tables, allowance has to be made, both for those of the non-nitrogenous constituents of the food, which would probably become at once effete, and also for the different respiratory and fat-forming *capacities*, so to speak, of those portions of the food which are digestible and available for the purposes of the animal economy. For, it will be remembered—that the Bran, which was given in such large quantities in some cases, contains a large quantity of indigestible and unnutritious, and consequently effete woody fibre—that it must require as much as from twice to thrice as much of the starchy series of compounds, as of the fatty

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* See also the Diagrams.

ones, to afford the same equivalent of respiratory and fat-forming material—and again, that the nitrogenous constituents, if they took any part in these processes, would have also their own special equivalent or capacity, in these respects. Further, it should be borne in mind, that even after all due allowance has been made for those various sources of discrepancy in the actual figures of the Tables to which we have referred, the amounts which we may suppose to be thus corrected, would still include all those variations—whether arising from differences of external circumstances—from individual peculiarities in the animals themselves—from the different amounts stored up as increase according to the adaptation of the foods—or from the many other uncontrollable circumstances, which must always interfere with any attempt to bring within the range of accurate numerical measurement, the results of those processes, in which the subtle principle of animal life exerts its influence.

Bearing then those points in mind, which must tend to modify the indications of the actual figures in the Tables, it will appear, we think, that the coincidences in the amounts of available respiratory and fat-forming constituents, consumed by a given weight of animal within a given time, or to produce a given amount of gross increase, are much more strikingly shown throughout the numerous results represented in these Tables, than *à priori* we could have expected to find them. With this general uniformity, however, as to the amounts of non-nitrogenous substance, consumed under given circumstances, or to produce a given result, those of the nitrogenous constituents are found to vary in the proportion of from *one* to *two*, or even *three*; very much more indeed, than is consistent with the idea that the supply of these had regulated either the amounts of food consumed, or of increase produced. There may, indeed, be some individual discrepancy in the figures, not easily accounted for by any of the circumstances to which we have referred; and which might perhaps appear to lead to opposite conclusions to those which we would draw from the Tables as a whole. But, we think it will be much more reasonable to attempt to explain—or, considering the nature of the subject, even to admit as inexplicable—a few discrepant cases, than to reject, on their account, the general testimony of much more numerous, consistent, and otherwise sufficiently conclusive results.

Looking first to Table XXII., which gives the amounts consumed *weekly per* 100 *lbs. live weight in Series* I., we find, that there is a generally less amount of the *non*-nitrogenous constituents consumed in the first set of four pens than in the second. This somewhat less amount of non-nitrogenous constituents consumed per 100 lbs. live weight per week in the first set, is, how-

ever, more than compensated by the amount of nitrogenous matter consumed; and there is, with this larger amount of nitrogenous matter in the food, upon the whole a somewhat larger amount of total organic substance consumed in the first set of four pens than in the second. If we now look down these columns, either of total dry organic matter, or of non-nitrogenous substance, and exclude, as we may, pens 9, 10, and 11 (in which there was given the excessive amounts of bran, and the foods could not be considered as of fattening quality), we cannot fail to see, a very close uniformity in the amounts consumed of both these classes of constituents throughout the nine pens. Thus, taking first the non-nitrogenous substance, the range throughout these nine comparable pens is between the two extremes of 17½ lbs. and 22½ lbs. Again, in the column of total organic substance, the range in these nine pens is from 22 lbs. to nearly 28 lbs.; but among eight of them, it is only from 24½ lbs. to not quite 28 lbs. The column of nitrogenous substance, on the other hand, shows a range in the amount of weekly consumption per 100 lbs. live weight of animal, in these nine pens, of from 2·9 lbs. in pen 5, to 8·8 lbs. in pen 1. The range of difference, therefore, in the amounts of nitrogenous substance consumed, instead of being, as with the other two constituents, in the highest only about 25 per cent. above the lowest, is more than 200 per cent.

Turning now to Table XXIII., which gives the same particulars for the Second Series of experiments, owing to the generally better balance of the constituents of the foods throughout this Series, we need not exclude any of the 12 pens from our comparison. Looking first at the column of total *non*-nitrogenous substance (see Division 2), we find the range of weekly consumption per 100 lbs. live weight of animal, to be from 14½ lbs. to 23½ lbs. This is, it is true, a considerably greater range in the amounts of non-nitrogenous matter consumed, than in the pens we compared in Series I. If, however, we were to exclude pens 1 and 8 from the comparison in this Second Series, we should find, that the amounts of non-nitrogenous matter consumed in the remaining ten pens range only from 19·9 lbs., or say 20 lbs., to 23½ lbs.; and again, the range in the amounts of the total organic substance, consumed in these ten pens, is only from about 25 lbs. to 31 lbs. The difference in the amounts of nitrogenous matter consumed, however, is from 3·9 lbs. to 8·7 lbs—the highest being, therefore, more than 120 per cent. above the lowest.

Comparing the Second Series with the First, the amounts of non-nitrogenous substance consumed weekly per 100 lbs. live weight, are more uniform throughout the former than the latter. They are, however, rather higher in the Second Series with the

Barley-meal, than in the first with the Indian corn. But, if we refer to the columns of fatty matter for the two Series respectively, we see, that there is always a somewhat larger amount consumed of this substance, with its high respiratory and fat-forming capacity, in the food of the First Series, than in that of the Second; and, the due allowance for this, would in several cases make the differences in the amounts of non-nitrogenous matter consumed in the two Series, even somewhat more inconsiderable.

In the Third Series (see Division 2, Table XXIV.), we have the range in the non-nitrogenous matter consumed, from about 16½ lbs. to about 25½ lbs.; and in the total dry organic substance, from about 21 lbs. to about 31½ lbs. On the other hand, in this Series, with the highly nitrogenous Cod-fish, we have, in the amounts of nitrogenous matter consumed, a very small range throughout these five pens compared with that in the other Series —it being only from 4·3 lbs. to 5·9 lbs. We shall see presently, however, that although there was in this Third Series, a less range in the amounts of nitrogenous substance consumed weekly per 100 lbs. live weight, than in those either of the pure non-nitrogenous, or of the total organic constituents—yet, there was, in the amounts consumed *to produce a given weight of increase* in this Series, a wider range in the column of nitrogenous than in that of the other constituents.

Throughout these experiments, then—in which the animals were allowed to fix for themselves the limit of their consumption, according to the composition of the foods within their reach—we have, as shown in the Tables XXII., XXIII., and XXIV., a very striking coincidence in the amounts of pure non-nitrogenous, or of total dry organic matter, consumed weekly for 100 lbs. live weight of animal; and, with the slight exception in Series 3, a very much greater diversity in the amount of the *nitrogenous* constituents so consumed. There are, indeed, some exceptions to the regularity in the amounts of non-nitrogenous, and of gross organic substance consumed; most of which are found however, on examination, to prove no exceptions to the conclusion—that, other things being equal, it was the respiratory and fat-forming exigencies of the animals, and not the supplies of the nitrogenous substances in the food, that regulated the amounts of it consumed. Thus, in Series I., we have in pens 9, 10, and 11 a generally less amount of non-nitrogenous and total organic substance, but especially of the latter, consumed to a given weight of animal, than in the other pens. But, the difference in the amounts of these substances available for the purposes of the animal economy, in these pens as compared with the rest, is in fact much greater than the figures in the Table seem to indicate; for, it will be remembered, that in these a very large proportion of the food was Bran, containing

a very large percentage of bulky and innutritious woody fibre, which, appears to have put a limit to consumption, scarcely beyond the point required for the mere maintenance of the respiratory process; and, in these three pens, the animals gave scarcely half as much increase for a given amount of grass food consumed as the average of the Series. Hence, as is obvious, the amounts consumed weekly per 100 lbs. live weight, as given in the Table, include but a small amount devoted to the purposes of increase; and represent therefore, besides that which was only innutritious woody fibre, little more than was demanded by the respiratory requirements of the animal. There was, it is true, in pen 5, a comparatively small amount of total organic matter consumed per 100 lbs. of live weight; but a reference to the columns of nitrogenous and of non-nitrogenous substances respectively, will show, that the deficiency in this case was rather in that of the amount of the nitrogenous, than of the non-nitrogenous constituents. It must be remembered too, that the food in this pen 5, which was Indian meal exclusively, would possess a higher respiratory and fat-forming capacity, than that in any other pen in the Series—and, unlike pens 9, 10, and 11, a very small amount of innutritious woody fibre. Still, the amount of non-nitrogenous substance consumed weekly per 100 lbs. live weight, was comparatively small in this pen; but we shall presently find, that notwithstanding this comparatively small amount of the non-nitrogenous matter consumed to a given weight of animal within a given time, and also, that we had in this pen three well fattened pigs—yet, in fact, *in proportion to the amount of increase produced*, the amount of non-nitrogenous matter consumed, was as large here as in any case in the Series. In pens 1 and 3 again, we have a somewhat low amount of non-nitrogenous substance consumed, considering that there was in both pens a good rate of increase. In both these pens, however, the amounts of nitrogenous substance consumed were very high; and, owing to this, the amounts of total organic matter consumed are also somewhat high. It would appear, therefore, that in these cases, the somewhat small amounts of non-nitrogenous substance consumed were compensated by the larger amounts of nitrogenous substance. Part of the larger amounts of the non-nitrogenous substances taken in the other pens, would seem therefore to have been substituted, in these cases, by the nitrogenous substances.

In Series II. there are very few notable exceptions to the rule of regularity in the amounts of non-nitrogenous, or total organic matter, consumed by a given weight of animal within a given time. There is, however, certainly one such exception; which, indeed, might seem to lead to very opposite conclusions to those which

we have formed from the experiments as a whole. Thus, in Pen 1 of Series II., with Beans and Lentils as the only food—which contained a larger proportion of the nitrogenous constituents than any of the other dietaries of the Series—we have little more than two-thirds as much of non-nitrogenous substance, and only four-fifths as much total dry organic matter consumed as the average of the Series. In this pen, however, a larger amount of total dry organic substance, was consumed *to produce a given amount of gross increase*, than in many of the pens in the Series where the proportion it contained of nitrogenous substance was very much less. And, when we further consider, that with an excessive proportion of nitrogenous substance in the food of the fattening pig, we have found there was more of a tendency to grow in frame and flesh than in other cases—and again, that the larger the proportion of flesh in the increase, the less will be the proportion in it of real dry substance—it will be seen, that if there were a smaller amount of food consumed, there would also, at the same time, be a smaller amount of increase produced by it—especially of that formed from the non-nitrogenous constituents of the food, and which would contain the largest proportion of real dry substance. Hence there would be, though a small amount of non-nitrogenous constituents consumed, a larger proportion of them available for the respiratory process. This apparent exception, is not then necessarily adverse to the view, that the respiratory process was the gauge of consumption.

In Series III. again, where we have, in Pens 1 and 2, a comparatively small amount of non-nitrogenous matter consumed, the food consisted, in a large proportion, of the highly nitrogenous Cod-fish; and in both of these cases, we had not only a very good proportion of increase to food consumed, but the pigs in these pens were very fat and well ripened; and hence, a large proportion of their increase would be real dry substance. It is then, again when the proportion of nitrogenous constituents in the food was large, that a small amount both of non-nitrogenous substance and of gross dry organic matter, seemed to have sufficed for the wants of the animal. This result is in itself interesting; and it may perhaps point to a comparatively greater efficiency in the already animalized protein compounds supplied in the Cod-fish, than in those derived, as in the other cases, from the purely vegetable diets. Whether or not there may be any truth in such an explanation of the great efficiency of this highly nitrogenous food, we presume that this result with the unusual, or at least only very locally adopted food, of *fish*, can scarcely be taken as contradicting the indications of the natural requirements of the fattening pig, such as we have found them to be so consistently brought out, in so large a series of experiments, in which he was fed upon his more usual and appropriate food.

Reviewing then, as a whole, the results of these Three Series of experiments with Pigs, and carefully considering the bearing of the various circumstances which must influence our reading of the actual figures of the Tables relating to them—we think it cannot be doubted, that here, as we have already shown in the case of our Sheep experiments, the evidence is very clear, that it is the *non*-nitrogenous rather than the *nitrogenous* constituents of the foods, that have been the gauge of, or fixed the limit to—*consumption.*

We now come to the question of the relationship respectively, of the nitrogenous and of the non-nitrogenous constituents of the food, to the amount of *increase in live weight* obtained in the fattening Pig. This point is illustrated in Tables XXV., XXVI., and XXVII., which give the amounts of fresh food, or of its various constituents, which were consumed to *produce* 100 *lbs. increase in live weight of animal.** In considering these Tables, we must of course, as before, read the indications of the actual figures, as modified by the obviously different *capacities* for the purposes of the animal economy, of the substances the amounts of which they in each case represent. We must remember too, that as in the Tables showing the relationship of *consumption* to *respiration*, the figures included also the amounts which served to increase the weight of the animal—so now, in these Tables professing to show the relationship of the *increase* to the *constituents consumed*, the figures at the same time include the amounts which have been expended in the respiratory process. And further, we should recal to mind the fact, that even the increase itself, will represent different amounts of total dry or of *non*-nitrogenous substance, expended to produce it, according to the amounts respectively, of fat or of flesh, which it may contain.

If we cast the eye down the columns of non-nitrogenous substance consumed, and more particularly those of the total organic matter, in these Tables (see Division 2, Tables XXV., XXVI., and XXVII.), we see, with but few exceptions, a very strikingly close coincidence in the amounts of these, required *to produce* 100 *lbs. gross increase* throughout these three Series of experiments with Pigs. Some of the exceptions, such as those where a large quantity of Bran was used, are at once explained by a consideration of the more obvious qualities of that food; and some of the minor differences, by that of the different respiratory and fat-forming capacities of those portions of the foods which would be digestible and available for the purposes of the animal economy. Turning now to the adjoining columns in these Tables, those of the *nitrogenous* substance consumed to produce a given weight of increase throughout these three Series, we find the amount of it as strikingly various as that of the non-nitrogenous

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* See also Diagram II.

matter had been otherwise; and certainly, in no way consistent with the view, that the increase of the fattening animal bears any direct relationship to the supplies in its food of the nitrogenous or plastic constituents.

Taking the results of each Series separately;—we may first call attention to Table XXV., which refers to the first Series of 12 pens. If we again exclude pens 9, 10, and 11 from the comparison—and certainly the foods in those pens could not be called fattening foods—we see, that amongst the other nine, the amounts of non-nitrogenous substance consumed to produce 100 lbs. increase in live weight, ranged from 275½ lbs. to 377½ lbs.; and that in seven of the pens the range was only from 309 lbs. to 377½ lbs. In pens 1 and 2, where the food contained so large a proportion of nitrogenous substance, we see that the amounts of non-nitrogenous substance consumed to produce a given amount of increase, was indeed comparatively very small. But, if we look to the column of *total* dry organic matter, we shall find that the amount of this required to produce a given amount of increase was greater in these two pens than in several cases in the Series where the food contained little more than half as much nitrogenous substance. The large proportions of nitrogenous substance in the foods of pens 1 and 2, would seem therefore, not to have really economised material in the production of gross increase—but only to have *substituted* an even somewhat smaller amount of non-nitrogenous constituents in that process; whilst, as we have said, there is reason to believe, that a given amount of increase obtained from the more non-nitrogenous diets, contains more fat, and with this a larger proportion of real dry substance.

Again, if we look down the column of total dry organic substance consumed to produce a given amount of increase, we find, that the range for the nine pens is from 382 lbs. in pen 8, to 533 lbs. in pen 3; but of this comparatively large amount of total organic substance consumed in pen 3, to produce 100 lbs. of increase, a larger proportion was nitrogenous substance than in any other case of the nine pens. In this pen too, with this very large amount of *nitrogenous* substance, consumed *to produce a given amount of increase*, there was indeed the minimum amount in the Series of *non*-nitrogenous substance, consumed *weekly per* 100 *lbs. live weight.* Hence, it would seem, that the pigs had been pushed to the consumption of a larger amount of nitrogenous substance than they required, or could turn to any useful account, in order to secure a sufficiency of the *non*-nitrogenous substances, which existed in the food in such comparatively small proportion.

Again, in the pen in which there was the next largest amount of total organic substance, consumed to produce a given amount

of increase, namely, pen 4, the food contained both Bran and a very large proportion of the highly nitrogenous Bean and Lentil meal. There is, indeed, throughout this Series, scarcely an instance of deviation from the regularity in the amounts of non-nitrogenous or dry organic substance, consumed to produce a given amount of increase, which is not so accounted for by the character of the food, or by the known progress of the animals, as consistently to indicate a very close relationship between the available *non*-nitrogenous constituents of the food and the increase of the so-called "*fattening*" animal. In the column of the amounts of *nitrogenous* constituents, consumed to produce a given weight of increase, we have, however, no indication whatever of any direct numerical relationship of the one to the other. In one of the pens which we have excluded from our calculation—since the food in it could not be considered of good fattening quality—there was indeed three and a half times as much nitrogenous substance, consumed to produce a given amount of increase, as in one or two of the other pens. But, excluding as before, pens 9, 10, and 11, from the estimate, we even then find, that the range in the amounts of nitrogenous substance, consumed to produce 100 lbs. of increase, is from 57 lbs., as in pen 5, or $58\frac{1}{4}$ lbs., as in pen 7, to 138 lbs., as in pen 1, and even to 161 lbs., as in pen 3. We have, then, among the nine pens with fattening foods, a variation in the quantities of nitrogenous substance, consumed to produce a given amount of increase, in the proportion of from 1 to nearly 3.

In the First Series then, taking the nine pens, we have, even in the actual figures of the Table (XXV.), a very much closer relationship between the increase produced, and the amounts consumed—of non-nitrogenous, or total organic—than of nitrogenous substance. Whilst, as we have pointed out, the variations in the amounts of the non-nitrogenous substance consumed are generally such as to show, even more clearly, that, beyond a narrow limit of nitrogenous supply, the proportion of increase obtained to a given quantity of this consumed, is in a very rapidly decreasing ratio. There is evidence, however, in the results, that probably in one or two cases in the Series, the nitrogenous supply in the food was at the minimum, if not even somewhat below the amount best adapted as the food of the fattening pig.

Looking to the same points in Series II. (Table XXVI.), we see, that there is a very much closer relationship in the amounts of non-nitrogenous or total dry organic substance, consumed to produce a given amount of increase, than in Series I.; and there is at the same time, a variation in the amounts of nitrogenous substance consumed, but little less than in the nine pens of the

former Series. Thus, among the whole twelve pens, with their as many different dietaries, the range in the amounts of the non-nitrogenous matter, consumed to produce 100 lbs. of gross increase, is only from 317 lbs. to 385 lbs.; and, that of the total organic substance, from 408 lbs. to 511 lbs.; but, that of the nitrogenous substance, is from 64 lbs. to 152 lbs. In the non-nitrogenous, or total organic substance, required to produce a given amount of increase, the range of variation in the highest amount is, therefore, only about 25 per cent. above the lowest; but in the amounts of the nitrogenous substance, the range of the highest above the lowest is nearly 140 per cent. Looking to the figures a little more closely, we see, that in the second set of four pens in this Second Series, where the amount of nitrogenous substance in the food was on the average only about half as much as in the first set of four pens, there was at the same time, on the average, a little more non-nitrogenous substance, consumed to produce a given result. In these four pens of the second set, however—with their comparatively low amount of nitrogenous substance—we have an average of about 50 lbs. *less*, of total dry organic matter, consumed to produce 100 lbs. of increase, than in the pens 1 to 4, where it consisted in so much larger a proportion of nitrogenous substance. Nor, will any one practically acquainted with pig feeding doubt, that the pigs in pens 5 to 8, where the food consisted in such very large proportion of Barley-meal, would progress more favourably as to the quality of their increase, or, that they would contain a larger proportion of fat, and, consequently, more of dry substance, than those upon the chiefly Bean and Lentil dietaries of pens 1 to 4. The coincidence, too, in the amount of total dry organic matter, consumed to produce 100 lbs. of increase, in the four pens where the Barley-meal, with its low supply of nitrogenous substance predominated, is very striking; and especially in three of them, it being in these respectively 449 lbs., 443½ lbs., and 444¾ lbs.; and, it was in these three pens, that the supply of nitrogenous substance was about the lowest in the Series. Again, in three of the pens in the first set of four, with the nitrogenous substance generally double that of the three last alluded to, we have also nearly as close a coincidence in the amounts of total dry substance consumed; though, as we have before noticed, it was here about 50 lbs. more than in the former. Thus, the amounts consumed to produce 100 lbs. of increase in the three pens with the highly nitrogenous food, are respectively 511½ lbs., 499¾ lbs., and 503 lbs.; instead of, as in the three former, only about 345 lbs.

The fact, that a generally larger amount of total dry organic matter, is required to produce a given amount of increase, the

more beyond a certain narrow limit, this organic substance abounds in nitrogenous compounds, is again seen, on comparing the pens 9 and 10 of this Second Series, with pens 11 and 12. In pens 11 and 12, we have a larger proportion of Barley-meal, and less of Beans and Lentils, and therefore, less of nitrogenous substance consumed, than in pens 9 and 10; and with this larger proportion of nitrogenous substance in the food of pens 9 and 10, we have from 50 lbs. to 70 lbs. more of gross dry organic substance required to produce 100 lbs. of increase, than in the former. In pens 9 and 10, the food was the same in both cases. But the amounts of total organic substance consumed to produce 100 lbs. of increase, vary in the two from 452 lbs. to 479 lbs. In pens 11 and 12, again, the foods were also duplicates. They contained, as we have said, less nitrogenous substance than those of pens 9 and 10; and we have in them, the lowest amounts of total organic substance, consumed to produce a given amount of increase, of any in the Series; nor is there in these two cases, a variation of half a pound in the amount of total organic substance consumed to produce 100 lbs. of increase; it being in pen 11, 408·1 lbs., and in pen 12, 407·7 lbs.

Notwithstanding, however, the very clear indications which this Second Series affords, of the much closer connection between the amount of increase produced, and that of the non-nitrogenous or total organic substance of the food, than that of the nitrogenous constituents, it must not be overlooked, that it was in pen 1, where the proportion of nitrogenous substance in the food, was higher than in any other pen, that we have even a slightly less amount of *non*-nitrogenous substance, consumed to produce a given amount of increase, than in any other case in the Series. The amount of *total organic substance*, consumed for the same result in this pen 1, was, however, somewhat greater than the average of the twelve pens, and greater also than in six of the individual pens, in several of which the amount of nitrogenous substance was only about half as great as in this pen 1. It would seem, therefore, that this large proportion of nitrogenous substance in the food of pen 1, had yielded a comparatively low rate of gross increase; whilst this increase, the result of the highly-nitrogenous diet, would probably consist in a less proportion of solid fat, and, therefore, in a less proportion also, of real dry substance.

The results of Series II., then, very clearly show, the very close connection, between the amount of increase produced and the supply in the food of the non-nitrogenous constituents, or of total organic substance—independently of its nitrogen, when this exceeds a somewhat narrow limit; and again, as in Series I., that the amount of *nitrogenous* substance, on the other hand, consumed

to produce a given amount of gross increase, may vary very greatly, the range being, in fact, in this Series II., in the proportion of from 1 to nearly 2½.

Turning now to a consideration of the same particulars for the Third Series, as given in Table XXVII.—it will be remembered, that the food in this Series contained a large amount of the highly nitrogenous Cod-fish; and also, that in this Series there was, in the *weekly consumption by a given weight of animal*, a less range from the minimum, of either class of constituents, but especially of the nitrogenous ones, than in either of the other Series. In this Table XXVII., too, showing the amounts of constituents consumed in this Series, *to produce a given amount of increase*, we have also a less range in both classes of constituents than in the Series I. and II. Still, even here, the range in the amounts of nitrogenous substance, consumed to produce a given amount of increase, is somewhat greater, than that of either the pure non-nitrogenous, or the total organic substance. The smallest amounts, both of *non*-nitrogenous and of total organic substance, consumed to produce a given amount of increase, in this Series, are in pen 2; in which the amounts of the *nitrogenous* substance also was the least. And again, the *largest* amount of non-nitrogenous, or of total organic substance required, were in pen 3, where there was at the same time, the largest supply of the nitrogenous substances. The smallest amount of total dry organic substance, required to produce a given amount of increase, *throughout the three Series* indeed, was in the pen 2 of this Third Series; and it was here, that the food contained a less proportion of indigestible effete matter, than in any other pen in the three Series, whilst at the same time, it had a higher respiratory and fat-forming capacity, and a large proportion of previously animalized protein compounds. With the exception of this pen 2, in which the food was of such concentrated flesh-forming, fat-forming, and respiratory capacity, the amounts of non-nitrogenous, and of total organic substance, consumed to produce a given amount of increase throughout the Third Series, agree very closely; and the amounts in this Series also correspond very closely with those in the Series I. and II. Whilst, however, in the four pens of Series III., now compared together, the amounts of non-nitrogenous, or of total organic substance, consumed to produce a given result, vary only about 10 per cent. in the highest above the lowest—those of the nitrogenous substance in the same pens, varied about 30 per cent.

Upon the whole, then, although the results of this Series, with the unusual food of Cod-fish, show less strikingly than those of the former ones, the closer connection of the non-nitrogenous, than of the nitrogenous constituents consumed, with the amount

of gross increase produced—yet still, so far as they go, they are consistent in their indications.

Reviewing, as a whole, the results of the Three Series of experiments with Pigs—if we consider, that it is the results obtained under the subtle agency of animal life, that we are seeking to measure and express in figures—and if we also bear in mind, the various sources of modification to which our actual figures must be submitted, in order to attain their true indications, we think it cannot be doubted, that beyond a limit, below which few of our current fattening Pig foods are found to go, it is rather their supplies of available *non*-nitrogenous constituents, than those of their nitrogenous ones, that measure, both the *amount consumed to a given weight of animal within a given time*, and *the increase in weight obtained.* This result with Pigs, is too, perfectly consistent with that obtained in our experiments with Sheep.

It will be noticed, that wherever the amount of nitrogenous constituents consumed, either by a given weight of the animal within a given time, or to produce a given amount of gross increase, was in these pig-feeding experiments, comparatively large, it was where a large proportion of the Leguminous seeds was employed. Some writers who have taken the per centage of the nitrogenous compounds of food, as the measure of its feeding value, have recognised, and endeavoured to explain in various ways, the fact, that the records of feeding experiments, do not award to the Leguminous seeds, a feeding value in proportion to their richness in these compounds; and they have supposed, that it is the accepted deductions from the practical feeding experiments, and not the theoretical conclusions, that are in error.* Thus it has been objected against the teachings of such experiments—that the variations in the composition of foods of ostensibly the same description used in different cases, has not been determined; that the test has been the *gross* increase or loss in weight; that the increase may be only *fat* formed from starch, &c.; that loss in weight, if any, may be the result of activity, and not of defective diet; that the food in the different cases compared, has been employed in different states, that is, coarse or fine, raw or cooked; that the animals have been variously circumstanced as to temperature, exposure, and activity; that individual animals have very various tendencies to increase, and so on. Now, we believe, that not one of all these objections can vitiate the comparisons which we have made; unless indeed, in some degree, the one which refers to the difficulty of determining whether the *gross* increase obtained be composed chiefly of *fat* formed from the starch and oily series of compounds, or whether of *flesh*

* See Postscript at the end of the Paper.

from the nitrogenous ones. We believe, indeed, from direct experiments which we have made, that, in fact, the composition of our domestic animals generally—but especially that of the gross increase of the so-called "*fattening*" animals—consists of a much larger proportion of fat, and a much less one of nitrogenous compounds, than is usually supposed. The whole question of *Animal Composition*, however, as illustrated by the experiments referred to, we hope to treat of separately, on some other occasion. But, apart from the considerations involved in the question of the varying composition of the Increase, or from the fact that our own feeding experiments (which, so far as we are aware, are the largest comparable series bearing upon the point), afford testimony in the same direction, we think, that there is evidence of another kind, of the general correctness and truth of the indications of practical experiments which have thus been objected to. Thus, the comparative prices of the Leguminous seeds and the Cereal grains, may be taken as some condemnation of the measurement of their comparative feeding value, according to their percentage of nitrogenous constituents. In matters of this kind, indeed, especially when staple and generally-used articles of food are concerned, the *market* is one of our shrewdest judges.

While speaking of the comparative feeding values of the Leguminous seeds and the Cereal grains, we may here casually allude to some other points of much interest bearing upon this question, and which are suggested by a consideration of the general results of our feeding experiments, taken in connection with those on the manuring and growth of our Leguminous and Graminaceous corn and fodder crops.

As a general rule it may be said, that, weight for weight, the Leguminous seeds contain about twice as much of nitrogenous compounds as the Cereal grains. We have elsewhere stated, that, speaking generally, an acre of land, under equal circumstances of soil and season, will frequently yield twice or thrice as much nitrogenous constituents in a Leguminous crop, as in a Cereal grain; and again, that in the latter, an *increase* of produce is not obtained by the use of nitrogenous manures, except at the cost of more nitrogen so supplied in manure, than is contained in the increase thus produced. How is it, we would ask, if this be the case, and if really foods are valuable, at least for the fattening of stock, in proportion to their richness in nitrogenous constituents—how is it, we would ask, if this be case, that, according to the usual state of the market, we could obtain for a given sum about twice as much nitrogenous substance in the Leguminous seeds as in the Cereal grains?—or how is it, on the other hand, that the Leguminous crop does not, much more than is in fact the case, supersede the Cereal grain in the field, the

feeding-shed, or even on the table? We have, it is true, much yet to learn, of those minor differences of composition, to which are due the greater or less adaptation to the instinctive wants of the system, of the various constituents of which our staple articles of food are made up. But we think, that in no considerations of this kind, could we seek an adequate solution of our question. On the other hand, we believe, that in the Leguminous seeds the due proportion of the nitrogenous to the non-nitrogenous constituents is not observed. If this be true, it is obvious, that in the use of the Leguminous seeds instead of the Cereal grains, more than is requisite of the nitrogenous constituents will be taken into the system, before the adequate supply be attained, of the *non*-nitrogenous or respiratory and fat-forming materials. Nor, as our markets go, would the relative prices of these seeds and grains be found to interfere with a somewhat lavish use and expenditure of nitrogenous compounds in the former.

In the facts which are here briefly stated, we have surely very curious and interesting matter for reflection; and we have brought to our view, a striking instance of the mutual adaptations which are everywhere traceable in the practical application of natural laws. Thus, we have said, that under given circumstances, the Leguminous crop will give a much larger acreage yield of nitrogen than the Cereal grain; and that an increase of produce of the latter is not obtained by the use of nitrogenous manures, except at the cost of more nitrogen in the manure than is contained in such increased produce; whilst, in point of fact, in the ordinary practice of rotation in this country, the growth of a Leguminous corn or fodder crop, with its high percentage and actual amount of nitrogen, is itself, frequently either the direct or indirect source of the nitrogenous manure by which the increased Cereal is obtained. And, again, this Cereal, obtained at the *cost* of, but with its lessened *produce* of—nitrogen, is found in practice to be, weight for weight, of equal, or of a more highly feeding value, than the more highly nitrogenized Leguminous product, which perhaps has been expended to produce it. It would thus appear, that the demands of the respiratory function, which have been seen more than any other to regulate the consumption of food, would, in point of fact, not be satisfied in the use of the Leguminous diet, unless by a consumption or expenditure of an amount of nitrogen beyond that which the due balance of the constituents of food would seem to require; whilst, on the other hand, in the use of the Cereal grain, its better proportion of the *non*-nitrogenous to the nitrogenous constituents, has only been attained, by the sacrifice of nitrogen expended in its growth. It would seem, then, that whether we would seek our supplies of food in the direct use of the highly

nitrogenous products, or in the better balanced diet of the Cereals—in either case the end is attained, only at the cost or expenditure of nitrogen; in the one case, by the consumption of a larger amount of it in the food, than the due balance of its constituents would seem to require; whilst, in the other, this due balance has not been attained, without the loss of nitrogen during growth. The claims of health and natural instinct generally, leave little doubt which alternative should be adopted, at least in the case of human food. It becomes us, therefore, to investigate and understand, the practical bearings of these curious and interesting facts; for, upon the principles they involve, depend much for their success, those fundamental practices of the farm—the feeding of our stock for their double produce of meat and manure, and the adaptation of our rotations.

Apart from considerations of a more general and extended bearing, we may conclude our observations, with a few words on the more direct application of the results of our experiments to the practice of Pig-feeding.

It has been seen, that the larger the proportion of nitrogenous compounds in the food, the greater was the tendency to increase in frame and flesh; but, that the *maturing* or *ripening* of the animal—in fact, its "*fattening*"—depended very much more on the amount in the food, of certain digestible non-nitrogenous constituents. It also appears, however, when the price at which the more highly nitrogenous pig foods could be purchased, is taken into account, that a given amount of gross increase could be obtained, at a less cost with some of the highly nitrogenous foods, than with the more expensive ones, which have an undoubted character of superiority as pork producers. Were we, indeed, merely to take into consideration the amount of *gross* increase obtained for a given amount of food, of a given money value, there is no doubt, that in addition to the roots, or wash, or other matters, which generally form a greater or less proportion of the food of the pig, it would be the most advantageous, to rely almost exclusively to the end of the fattening process, upon the highly nitrogenous foods, dried fish, or animal refuse, and the Leguminous seeds, beans, lentils, and the like; for, in their use, not only could a given amount of gross increase be obtained at a less cost, than by the use of the Cereal grains, but the manure—the value of which must never be lost sight of in calculating the economy of the feeding process—would be much richer in nitrogen than if the latter were employed.

Unfortunately, however, it is not only a large amount of *gross increase* that secures to the farmer a good profit upon his styes. When pigs are fed freely upon highly succulent food, such as cooked roots, the refuse of starch-works, and the like, they are

frequently found to give a very rapid increase. But pork so fed, is found to sink rapidly in the salting process, and to waste considerably when boiled. And, although the first batch of pigs so fed may fetch a good price, their character is at once detected, and the market closed against a second sale. On the other hand, when pigs are fattened upon the highly nitrogenized Leguminous seeds—peas being, however, if not an exception, at any rate much less objectionable than some others—the lean is said to be very hard, and the fat also to waste in cooking. And again, when fish, flesh, and some strong flavoured oleaginous matters are given, the pork is found to be rank in flavour, or otherwise disagreeably tainted. Common practice, indeed, has settled, that the Cereal grains with their low per centage of nitrogenous compounds, constitute in the long run the staple food of the fattening pig; and the whole of the results of the experiments detailed in this paper bear testimony in favour of the correctness of this decision. Considering, however, not only the price at which a given weight of Leguminous seeds can be purchased, compared with that of the Cereal grains, but also the increased value of the manure from the former, and their probably greater tendency to give increase in frame and flesh —it is obviously the interest of the farmer, to use the highly nitrogenous Leguminous seeds, and perhaps even refuse flesh and other such matters, if at command, during the earlier and more growing stages. But it is certain, that if a constant good market for the pork is to be secured, these must greatly diminish, or cease entirely, and the supply of barley-meal, or other Cereal grain, be substituted for them as the period of fattening proceeds.

But not only do the principles involved in these suggestions, apply to the fattening of pigs, but, *mutatis mutandis*, they are applicable also to the fattening of other animals for the butcher; though—since in the case of fattening oxen and sheep, the Leguminous seeds, or other highly nitrogenous foods, constitute but a small proportion of the total food consumed—any deleterious influence which an excess of them might have upon the quality of the flesh, is less likely to occur. Indeed, all our feeding results consistently show, that the theory which assigns to the different substances used as fattening foods, a value in proportion to their per centage of nitrogenous compounds, is fallacious. It is probably a consideration of the obviously vast importance of the functions exercised by the nitrogenous structures and fluids of the animal body, which has given rise, in the scientific mind, to the notion of the relatively higher value of foods according to their richness in nitrogenous constituents. The economical or commercial estimate, is, however, founded upon

very different principles; and simply takes cognizance of the relations of supply and demand. Thus, air, water, and other natural agents, from their vast importance in sustaining animal and vegetable life, have a high value in a physiological or scientific point of view; but, from the relations of supply and demand, they are of little accounted money value. And so it is with the nitrogenous compounds of food; the functions which they alone can fulfil in the animal body are of the utmost importance; but in relation to the demand for them, it would seem, that our current food stuffs are much more likely to be deficient in certain other elements. Indeed, it would be difficult adequately to account for the comparatively high commercial value of the foods which contain a comparatively large proportion of certain *non*-nitrogenous compounds, except by supposing, that these, compared with the nitrogenous ones, were in less abundance in relation to the demands of the animal system for them.

It is not indeed, only in our current *fattening foods*, that the amount of certain elaborated and digestible non-nitrogenous constituents, rather than that of the nitrogenous ones, chiefly determines their relative value; for, a careful consideration of many human dietaries has led us to similar conclusions. When we remember too, that in using sugar, we do so at the cost of the rejection of all the nitrogenous compounds of the sugar-cane—and, in addition, of heavy money charges—it would seem improbable that it would become an article of diet of such growing necessity in all ranks of society, if our own home-produced foods were chiefly deficient in the nitrogenous constituents. Again, in the much higher price of butter than cheese, and of those cheeses which contain a large proportion of butter than those which are richer in nitrogen, it would seem to be further illustrated, that the demands of the body in relation to the supplies within its reach, are measured more by the amounts in the food, of the non-nitrogenous, than of the nitrogenous constituents. It would perhaps not be difficult to trace the undue estimates which, from scientific considerations merely, have been made as to the relative value of nitrogen and of mineral substances in manures, to a source somewhat similar to that which has given to the nitrogenous compounds of food, such a high theoretical value. For, as it is the mutual relationship of supply and demand of the nitrogenous and non-nitrogenous constituents of food, which must chiefly determine their relative values—so it is the relationship of supply and demand of the nitrogenous and mineral constituents of manures, that must give to them also their respective comparative values.

In conclusion, whilst we must not be understood, as in any way depreciating the value of a somewhat liberal supply of the

nitrogenous constituents of food, we would at the same time repeat, that by the concurrent testimony of all our feeding experiments, we are led to believe, that on the prevailing views, too high a relative importance is attributed to them. We have thought, therefore, that it would conduce to further progress in this most important field of inquiry, if the current opinions on the subject were somewhat modified. So general indeed has been the adoption, both on the Continent and in this country, of opinions on this subject, for which we have been unable to discern a sufficient basis of facts, and which at the same time, seem to be at variance with the indications of direct experiment, that we suppose little apology will be needed, for entering at the length we have done, into questions, which—involving as they do, the very fundamental principles of scientific feeding —appeared to us, to be some of the most interesting and important lessons which our experiments were calculated to teach.

Postscript. December, 1853.—Since this Paper was in type, we have had the pleasure of intercourse on some of the points to which it relates, with both Professors Liebig and Boussingault, and we are glad to gather, that they would perhaps somewhat modify the opinions which have generally been attributed to them. M. Boussingault indeed, referred us to the last edition of his 'Economie Rurale' (Paris 1851), in which both the text and the tables relating to this subject of feeding, have, compared with the edition published some years ago in this country, undergone considerable alteration and enlargement. In this new edition, M. Boussingault has clearly pointed out, that the true source of the discrepancy between the practical and theoretical feeding equivalents of the Leguminous seeds, depends upon their relatively too small amount of respiratory to nitrogenous constituents. Yet, he still supposes, that the theoretical estimate (*i. e.*, according to the percentage of nitrogen), must be considered as entirely satisfactory, when only comparing together foods within the same description or class; the following being the classes he enumerates:—

"1. Hays and Straws."
"2. Roots and Tubers."
"3. Oleaginous Grains."
"4. The Cereal Grains, the Leguminous Seeds, Oilcakes."

But, it will be seen, that neither the facts, nor the opinions, given in this Paper, are in accordance with this Rule.

EXPLANATION OF THE DIAGRAMS.

DIAGRAM I.—Shows the *proportions*, respectively of *Nitrogenous*, of *Non-nitrogenous*, and of *Total Organic substance*, consumed WEEKLY PER 100 LBS. LIVE WEIGHT OF ANIMAL, in the different pens throughout the Three Series of experiments with Pigs.*

Nitrogenous substance is represented by . . .	Black.
Non-nitrogenous substance	Yellow.
Total organic substance	Red.

For each constituent, the lowest amount of it consumed in any pen throughout the Three Series (see Tables XXII., XXIII., XXIV.), is taken as = 100; and the proportions of it in each of the other pens, in relation to this minimum amount taken as 100, is calculated by Rule of Three.

EXAMPLE—Showing the calculations for the three columns of *Pen* 1, *Series* 1. —The lowest amount of NITROGENOUS SUBSTANCE consumed weekly, &c., in any pen throughout the Three Series, was 2·91 lbs. in *Pen* 5, *Series* 1. This, therefore, is taken as the standard by which to compare the amounts of Nitrogenous substance, consumed in each of the other pens, and it is represented as 100; and, as seen in the Diagram, the column of *Nitrogenous* substance for Pen 5, Series 1, is coloured (black) only, up to the standard or base line, 100. In *Pen* 1, *Series* 1, the amount of *Nitrogenous substance* consumed weekly, &c., was 8·84 lbs. Therefore, we say :—

2·91 : 8·84 : : 100 : 304;

and, consequently, the column of *Nitrogenous substance*, for *Pen* 1, *Series* 1, is coloured (black), up to 304.

The lowest amount of NON-NITROGENOUS SUBSTANCE, consumed weekly, &c., was in *Pen* 1, *Series* 2—namely, 14·51 lbs. This, then, is the standard of comparison for all the other pens, as to *Non-nitrogenous substance;* and the column for that substance, in this *Pen* 1, *Series* 2, is coloured (yellow), only up to the base line, 100. In *Pen* 1, *Series* 1, the amount of *Non-nitrogenous substance* consumed, was 17·63 lbs.; and to get the proportion of this to the amount in the standard pen, we say :—

14·51 : 17·63 : : 100 : 122;

and hence, the column for *Non-nitrogenous substance*, in *Pen* 1, *Series* 1, is coloured (yellow), up to 122.

Lastly;—the lowest amount of TOTAL ORGANIC SUBSTANCE consumed, was 20·94 in *Pen* 2, *Series* 3; and, therefore, the column for this substance, for this *Pen* 2, *Series* 3, is coloured (red), only up to 100. The amount of

---

* Pens 9, 10, and 11 of Series 1, being however excluded, for the reasons which will be understood from the text referring to those Pens.

Total Organic substance, consumed in *Pen* 1, *Series* 1, was 26·47. Thus we say :—

20·94 : 26·47 : : 100 : 127 ;

and, the column for *Total Organic substance*, for *Pen* 1, *Series* 1, is coloured (red), up to 127. And so on, for each constituent, for all the other pens.

DIAGRAM II.—Shows the *proportions*, respectively of the *Nitrogenous*, the *Non-nitrogenous*, and the *Total Organic substance*, consumed to PRODUCE 100 LBS. GROSS INCREASE IN LIVE WEIGHT, in the different pens throughout the Three Series of experiments with Pigs.* The different constituents are represented by the same colours as in Diagram 1. As before, for each constituent, the lowest amount of it in any pen throughout the Three Series (see Tables XXV., XXVI., XXVII.), is taken as 100; and the calculations are also made on precisely the same plan as for Diagram I.

END OF VOL. XIV.

LONDON: PRINTED BY W. CLOWES AND SONS, STAMFORD STREET, AND CHARING CROSS.

DIAGRAM 1.

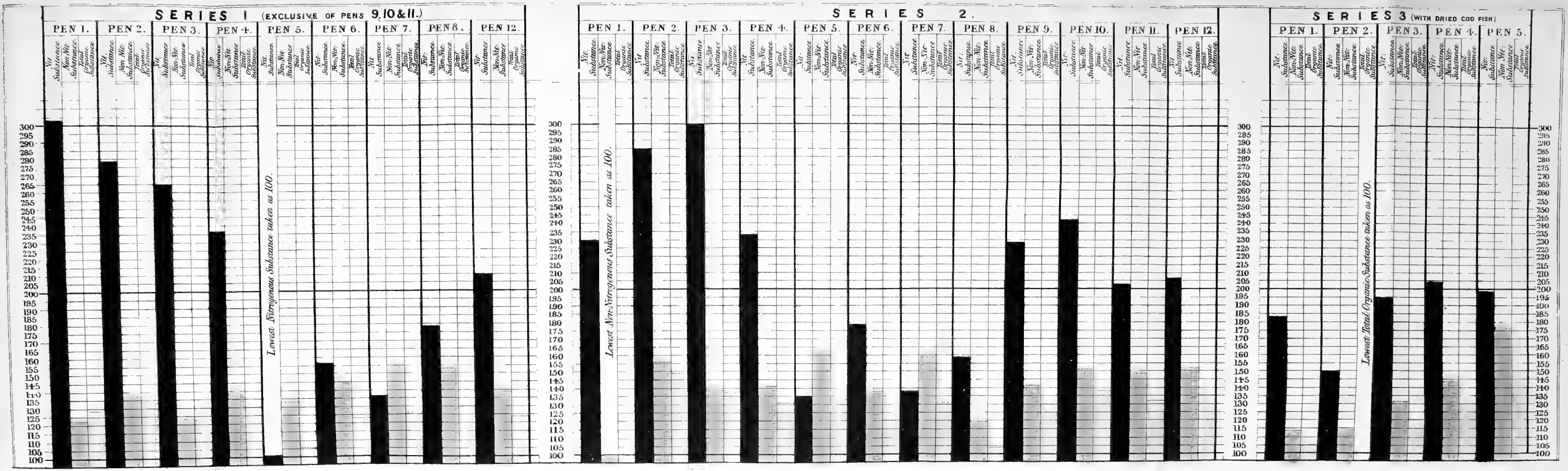
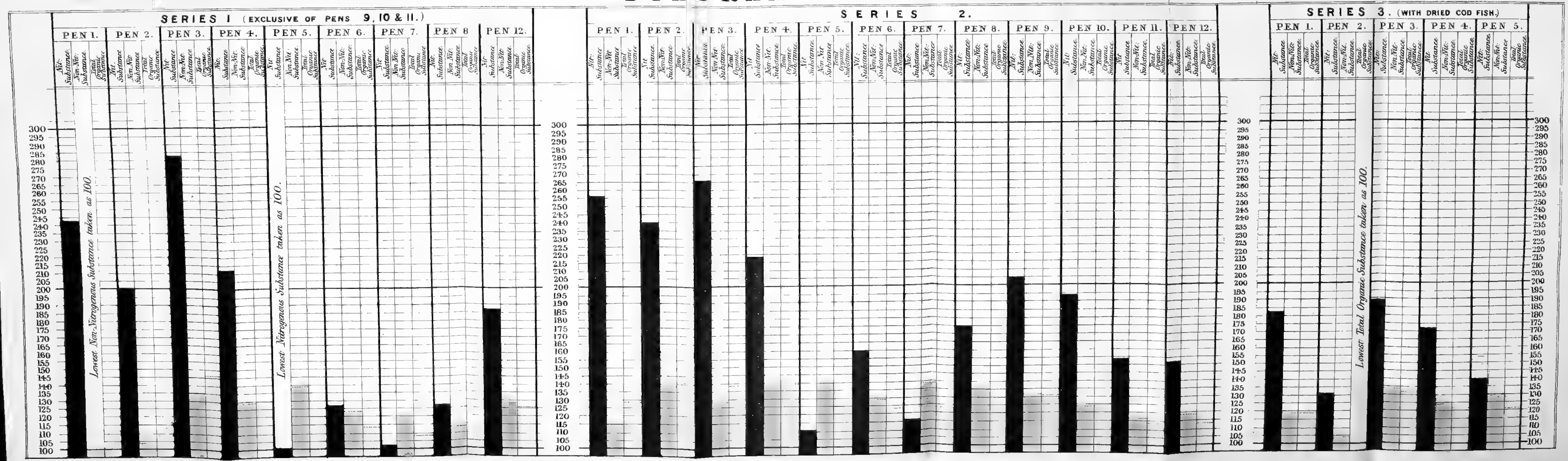


DIAGRAM 2.



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Royal Agricultural Society of England.

GENERAL MEETING.

12, Hanover Square, Saturday, December 11, 1852.

REPORT OF THE COUNCIL.

The Council have to lay before the Members, at the present General Meeting of the Society, the following half-yearly Report of their proceedings.

Since the last General Meeting in May, 45 Members have been lost to the Society by death, and the names of 82 others have been removed from the list on retirement or otherwise; while 80 new Members have been elected during the same period. The Society accordingly now consists of—

91 Life Governors,
149 Annual Governors,
720 Life Members,
3955 Annual Members, and
19 Honorary Members;

making a total of 4934. In the list of deceased Members on this occasion there occurs the illustrious name of the Duke of Wellington, one of the earliest Life-Governors and Vice-Presidents of the Society; who, though not himself a practical farmer, took a lively interest in everything tending to develop the resources of his country. In filling up the vacancy thus occasioned in the list of the Vice-Presidents, the Council have elected Sir John V. B. Johnstone, Bart., M.P., to that office; a gentleman who from the earliest period of the Society has given his unremitting attention to its affairs. They have also placed among the general Members of Council, in the vacancy thus

occasioned by the transfer of Sir John Johnstone's name to the list of Vice-Presidents, the name of Mr. Francis Woodward, of Worcestershire; one of those intelligent practical agriculturists to whom the Society owes so much of its public utility, and also one of the oldest Members residing in the district of the ensuing year's Country Meeting.

The Finances of the Society are in a satisfactory condition, as is shown by the Auditors' Balance-Sheet to the 30th of June last; since which time the Finance Committee have reported, that all claims against the Society submitted to them up to their last Meeting had been discharged, and that the funded property invested in the names of the Trustees of the Society now stands at 9990*l.* stock.

The Council receive with satisfaction the testimony of the Members to the still increasing value of the Society's Journal, and to the immediate and extensive influence resulting from the almost simultaneous transmission of the copies, free through the post, to the numerous Members of the Society diffused throughout the kingdom; as well as to that secondary and local influence arising from a knowledge of the facts and practical statements in its pages, personally communicated by each Member to other parties residing within the sphere of his own particular neighbourhood.

The Chemical Investigations continue to be steadily pursued by Professor Way, with valuable results obtained at each stage of his inquiries, leading on step by step through the labyrinth of nature's operations to new discoveries of the machinery by which she works in secret, and to the prospect of entirely new applications in the economy of agricultural laws for the cultivation of the soil and the manuring for crops. The Society have also been indebted to Professor Way for an interesting and valuable Lecture, delivered by him before the Members, during the past half-year, on the elucidation of Jethro Tull's principles of agriculture by modern science, and their illustration by modern facts.

The Council have on former occasions reported to the Society the communications in which they have been placed with the Foreign Office in reference to the question of a reduction in the price of Guano. They have now to report, that they appointed in June last a Deputation to wait on the Earl of Derby, the Prime Minister, for the purpose of representing to him the great importance of every means being taken to effect this object. His Lordship received the Society's Deputation most courteously, and assured them of his desire to take every measure that might at any time be in his power to promote the views and wishes of the Society on this subject. Since that interview the Council have resolved to offer, in addition to their current Prize of 50*l.* for an Essay on the geographical discovery of new supplies of Guano, a Prize for the discovery of a substitute for Peruvian Guano, under the following terms and conditions:—

I.—*Terms of the Prize.*

"One Thousand Pounds and the Gold Medal of the Society will be given for the discovery of a Manure equal in fertilising properties to the Peruvian Guano, and of which an unlimited supply can be furnished to the English Farmer at a rate not exceeding 5*l.* per ton."

II.—*Conditions of Competition.*

1. That in the offer of 1000*l.* and the Gold Medal of the Society, as a Prize for the discovery of a Manure equal in every respect in its fertilising properties to Peruvian Guano, the 1000*l.* shall be offered in one undivided sum.

2. That the standard of such Peruvian Guano shall be assumed to be the average result obtained by Professor Way, the Consulting Chemist to the Society, and published in his paper in the 10th volume of the Journal, pages 205-208.

3. That each competitor claiming the Prize shall send in with his sample a chemical analysis under seal, together with such practical proofs of the successful application of the manure to growing crops of grain, roots, and grasses, as he can produce duly certified by growers. That such samples of manure shall be liable to be subjected to all such further tests, and for such period of trial, as the Council may deem requisite.

N.B.—All claimants shall, on application made to them by the Secretary, be expected to supply, free of expense to the Society, such quantity of their respective manures as may be required for trial.

4. That no claim for the Prize will be entertained unless the claimant can satisfy the Council that an unlimited supply of the manure, at a price not exceeding 5*l.* per ton, will at all times be within the reach of the agriculturists of the United Kingdom.

The Council have already reason to believe that the attention which this Prize will call to the whole economy of manuring, and to the agricultural as well as sanitary question of the manurial resources of the kingdom, will lead to new and important results.

The Council, after full deliberation upon the following amended Conditions, proposed to them by their Veterinary Committee, and which have been accepted by the College, decided last month to renew the grant of 200*l.* for the current year to the Royal Veterinary College:—

1. That Members of the Society shall have the privilege of sending cattle, sheep, and pigs to the Royal Veterinary College on the same terms as if they were Members of the College.
2. That the College shall investigate particular classes of diseases or subjects as may from time to time be directed by the Council.
3. That, in addition to the increased number of Lectures given by Professor Simonds, the Lecturer on Cattle Pathology, to the Pupils in the College, he shall also deliver Lectures in the Council Room before the Members of the Society.
4. That the College shall supply a detailed Report of the cases of cattle, sheep, and pigs treated in the Royal Veterinary College.

The Council have had their attention called by His Royal Highness Prince Albert to the process of inoculation so extensively carried on at the present time in Prussia, Belgium, and the Netherlands, with a view to modify the severity of the symptoms of pleuro-pneumonia in cattle. In consequence of the information furnished by His Royal Highness to the Council, they authorised Professor Simonds, as the Veterinary Inspector of the Society, to proceed to Belgium, in August last, for the purpose of making himself personally acquainted with the facts connected with the conditions and results of the employment of this process. The Report which Professor Simonds has made to the Council on this visit of inspection will appear in the next part of the Society's Journal, along with a second Report on the occurrence of pleuro-pneumonia in the extensive herd of dairy cows belonging to Mr. Paget, of Ruddington Grange, near Nottingham, and which that gentleman has with great liberality

placed at the disposal of the Society for any experiments the Council may direct to be made on them. Professor Simonds has accordingly selected a certain number of animals for the purpose of experiment at Ruddington, and a further number to be brought up to the Royal Veterinary College in London for experiment under his own immediate superintendence. The Council have expressed to Mr. Paget their warmest thanks for the invaluable opportunity he has thus afforded to the Society of having direct investigations most satisfactorily made on the nature and cure of this fatal malady. The Council have also been favoured by Lord Stanley, H.M. Under-Secretary of State for the Foreign Department, Sir Emerson Tennent, Secretary to the Board of Trade, and Dr. Willems, of Hasselt, in Belgium, with communications on this subject.

The Country Meeting of the Society at Lewes in July last was in every respect satisfactory, excepting in the number of visitors, which, although amounting to 18,000 in the Show-yard, and 500 at the Pavilion dinner, was only one-half of the usual number. This comparatively deficient attendance, however, was owing to peculiar circumstances, over which the Society had no control; namely, a remote locality, unusually oppressive heat, and a general election going on throughout the country at the very time of the Meeting. The Reports of the Senior Stewards of Live Stock and Implements respectively at that Meeting will appear in the Society's Journal. The thanks of the Society were voted at the time to the Authorities of the Borough, to the Railway Companies, and to Professor Simonds, who delivered before the Members an interesting lecture on Parasitical Insects producing internal and external disease in the live stock of the farmer.

The Council have decided that the Gloucester Meeting for the South Wales district shall be held in that city in the week commencing Monday, the 11th of July. They have decided on the Prizes to be offered for Live Stock, and for the Prizes and Conditions of Implements for that occasion; deferring until after

Christmas the final arrangements for the Poultry Prizes. They have also decided on the Prizes to be offered for the Essays and Reports of next year. They have agreed to the arrangements for preparing the land for the trial of Implements, and have accepted the offer of the Contractor of Works to undertake their execution at the same rate of charge as in former years. They have received from the Professors at the Royal Agricultural College at Cirencester the offer of co-operation in any way by which their services may be thought, by the Council, best to promote the objects of the Society at the Gloucester Meeting.

In order to consider the most effectual means of obviating the over-feeding of live stock for breeding purposes exhibited at the Country Meetings of the Society, the Earl of Ducie, as its late President, undertook, after the Lewes Meeting, the task of entering into communication with the greater number of those gentlemen who had acted as Judges at the former Country Meetings of the Society; and the great majority of their opinions being in favour of decisive measures to put a stop to an evil so generally complained of, a Committee was appointed, who have made the following recommendations, which have been since adopted by the Council:—

1. To appoint three Juries of Condition for the three divisions of (1) Cattle, (2) Sheep, (3) Horses and Pigs; each Jury to be drawn by lot by the Steward of each division from the whole of the Judges comprised in it, and to consist of 9 Judges and 1 Steward; the Steward himself not to vote, but to take the decision in each case by a show of hands; the majority of votes to decide.
2. The following notice to be printed in red ink at the foot of each Certificate of entry, namely, "All animals sent for exhibition which shall in the opinion of the Jury be in an over-fed condition will be disqualified by the Jury before inspection by the Judges;" and a placard to be placed over the standing of every animal that shall be so disqualified, stating the reason of such disqualification.
3. The age of Bulls in the two classes of each division of cattle not to exceed four years and two years respectively on the 1st of July in the year of show for which they are entered.
4. No Bull in Class I. of each division of cattle to be eligible for a Prize unless a Certificate is produced of his having served not less than three

different cows within the three months preceding the 1st of June in the year of the show.

5. No alteration to be made in the limit of age for Cows, but that every Cow in-milk and not in-calf must be certified to have had a live calf within the twelve months preceding the date of the show.
6. No Heifer entered as in-calf to be eligible unless certified to have been bulled before the 1st of March in the year of show, and not to have been again in bulling subsequently to that date; nor her owner afterwards to receive the Prize, unless on the production of a further Certificate that she has produced a live calf before the 1st of February ensuing.
7. No Cattle or Sheep to have been fed with milk subsequently to the 1st of January in the year of the show.
8. No Boar or Sow to be shown that cannot walk on account of over-fatness.

The District for the Country Meeting in 1856 has been determined to consist of the counties of Huntingdon, Cambridge, Bedford, Buckingham, Hertford, and Essex.

The Council have the continued satisfaction of referring to the successful manner in which the practical operations of agriculture are directed by improved principles gradually adapted to each particular case by an extended knowledge of conditions; and of witnessing the same spirit of improvement that has so long sustained and encouraged the Society in the prosecution of its objects, now animating other agricultural communities in every part of the civilized world, and leading them to find their mutual advantage in friendly communication and the interchange of scientific and practical results.

By order of the Council,

JAMES HUDSON,

Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account, ending the 30th of June, 1852.

Receipts.

Receipts	£.	s.	d.
Balance in the hands of the Bankers, 1st January, 1852	1020	8	11
Balance of Petty Cash in the hands of the Secretary, 1st January, 1852	29	13	11
Dividends on Stock	176	10	11
Life-Compositions of Governors	189	0	0
Life-Compositions of Members	230	0	0
Annual Subscriptions of Governors	545	0	0
Annual Subscriptions of Members	2229	7	0
Receipts on account of Journal	199	2	6
Receipts on account of Country Meetings	1518	10	0
	£6137	13	3

(Signed) THOMAS RAYMOND BARKER, *Chairman.* | *Finance Committee.*
THOMAS AUSTEN.
C. B. CHALLONER.

Payments.

Payments	£.	s.	d.
Permanent Charges	170	12	6
Taxes and Rates	13	19	5
Establishment	593	0	8
Postage and Carriage	23	13	6
Advertisements	5	1	6
Payments on account of Journal	1365	0	7
Veterinary Grant: one year	200	0	0
Chemical Grant: half a year	100	0	0
Chemical Investigations: one-third of a year	100	0	0
Prize Essays	130	0	0
Payments on account of Country Meetings	572	11	1
Transfers of Subscriptions	23	2	0
Sundry items of Petty Cash	2	15	10
Balance in the hands of the Bankers, 30th June, 1852	2822	19	6
Balance of Petty Cash in the hands of the Secretary, 30th June, 1852	14	16	8
	£6137	13	3

Examined, audited, and found correct, this 10th day of December, 1852.
(Signed) GEORGE I. RAYMOND BARKER. | *Auditors.*
GEORGE DYER.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Monday, May 23, 1853.

REPORT OF THE COUNCIL.

The Council have to report that, since the last General Meeting in December, 47 Members have been lost to the Society by death, and the names of 134 other Members have been removed, on retirement or otherwise, from the list; while 170 New Members have during the same period been elected into the Society, which now consists of—

90 Life Governors,
147 Annual Governors,
739 Life Members,
3928 Annual Members, and
19 Honorary Members;

making a total of 4923 Members.

The current cash-balance in the hands of the bankers at the commencement of the present month was 3300*l.*, of which sum the Council ordered 800*l.*, on account of life compositions, to be invested in the public funds; the capital of the Society now being 10,764*l.*

The Council have the satisfaction of reporting, that the great practical objects, for the development of which the Society was originally founded, continue to receive a powerful impulse through the communications in its Journal; the trial and exhibition of Implements, show of Live Stock, and assemblage of farmers, at its Country Meetings; the practical discussions at its weekly Councils; and the personal co-operation of its

Members distributed throughout the kingdom. The two classes of direct investigations instituted by the Society—1, for the purpose of discovering new modes and conditions of chemical action in reference to animal, vegetable, and mineral matter; and 2, for obtaining a more exact acquaintance with the origin, nature, and treatment of diseases prevalent from time to time among the live stock of farmers—have been pursued with vigour by the professors of the Society, and have already led to important results in the one case, and to much valuable experience in the other. Progressive knowledge in agriculture is like that in every other art dependent on science for its advancement: as its sphere of operation becomes more extended, and its indications more accurately defined, it opens wider views of the application of those new principles, which are founded on incontrovertible facts, and have been deduced by the aid of science. As instances, however, are constantly occurring of hasty generalisations and illogical deductions, made in the application of science to agricultural data, and of the very different laws assigned, even by distinguished writers, to explain the production of the same phenomena, the Council recommend to the Members of the Society a strict adherence to that inductive process attendant on the comparison and discussion of actual facts, which regards abstract science as only the referee to be consulted, or the prime mover, whose subtle agency, like that of steam or electricity, is only available for practical objects, when its power is coerced, and its action restrained within required limits. The invaluable results which have already been obtained by such union of practice with science, lead the Council to the well-grounded expectation that still greater success will attend the future operation of that combined influence in promoting the cause of a sound and rational agricultural economy. The ensuing number of the Society's Journal, now in the press, will contain the following, among other communications:—1. Professor Way's Lectures before the Society, on his discovery of a natural source, in great abundance, of soluble silica, adapted for the preparation

of the double silicates, on which he believes the absorptive power of certain soils for manure to depend; and on his analytical results of investigations into the comparative nutritive value of natural and artificial grasses and weeds. 2. Professor Simonds's report of experiments made in this country, by direction of the Society, on animals affected with pleuro-pneumonia, and in which, by inoculation, according to foreign practice, with a morbid fluid taken from diseased lungs, the powerful counter-irritation of gangrenous inflammation to a certain extent in the system, rather than the production of pleuro-pneumonia itself, appears under certain conditions either to have subdued the ordinary symptoms of that fatal malady, or to have been in many cases the immediate cause of death. 3. Mr. Lawes's continuation of his valuable experiments on the feeding of animals. And, 4. Professor Wilson's Lecture before the Society, on the agricultural and technical treatment of flax.

The Gloucester Meeting will be held in the middle of July next. The entries of Implements, as will be seen by the following tabular statement, are more numerous than in former years, the area engaged for their exhibition amounting to 105,000 square feet, and the shedding required being nearly a mile in length:—

Year of Meeting.	Locality.	Entries of Implements.
1839	Oxford	23
1840	Cambridge . . .	36
1841	Liverpool . . .	312
1842	Bristol	455
1843	Derby	508
1844	Southampton . .	948
1845	Shrewsbury . . .	942
1846	Newcastle . . .	735
1847	Northampton . .	1321
1848	York	1508
1849	Norwich	1882
1850	Exeter	1223
1851	Windsor	No exhibition of Implements.
1852	Lewes	1897
1853	Gloucester . . .	2032

The entries for Live Stock will not close until the 1st of June,

but those already made indicate the probability of a very large show in that department, including, from the peculiar situation of the place of meeting, an interesting exhibition in the classes of Hereford, Devon, and Welsh Cattle, Welsh Ponies, Sheep, Pigs, and Farm-poultry. The termination of several lines of railway at the Gloucester station will prove highly favourable to the convenient transit of goods and passengers from every part of the country. The Council have made increased preparations for the due trial of the Implements competing for the Prizes of the Society, and for the exhibition of Thrashing Machines to be kept in motion during the show, for the public display of their construction and powers.

The Council have decided that the City of Lincoln shall be the place for the Country Meeting of the Society next year; and that the district for the Country Meeting to be held four years in advance of the present year, namely, in 1857, shall comprise the counties of Dorset, Wilts, Somerset, and Hants.

The Council have the pleasure of remarking, in conclusion, that there never was an epoch in the history of the Society, since the date of its formation, when its practical objects were more fully recognized than they are at the present moment, by the spontaneous desire of so many promoters of agricultural improvement of every class in different parts of the kingdom to become enrolled as Members on its list, the number of new Members elected into the Society during the last five months being nearly equal to the total number of those elected during the whole of the previous year.

By order of the Council,

JAMES HUDSON,

Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending the 31st of December, 1852.

RECEIPTS.

	£.	s.	d.
Balance in the hands of the Bankers, 1st July, 1852	2822	19	6
Balance in the hands of the Secretary, 1st July, 1852	14	16	8
Sale of Stock	1248	0	0
Dividends on Stock	157	12	3
Life-Compositions of Members	158	0	0
Annual Subscriptions of Governors	155	0	0
Annual Subscriptions of Members	1761	8	8
Sale of Journal	153	17	0
Receipts on account of Country Meetings	344	6	6
	£6816	0	7

(Signed) THOMAS RAYMOND BARKER, C. B. CHALLONER. } *Finance Committee.*

PAYMENTS.

	£.	s.	d.
Permanent Charges	178	12	6
Taxes and Rates	13	19	5
Establishment	437	15	7
Postage and Carriage	29	12	0
Advertisements	7	11	3
Journal	597	13	2
Chemical Grant	100	0	0
Chemical Investigations	200	0	0
Prizes	1543	7	6
Country Meetings	2575	5	0
Transfer of Subscription	1	0	0
Sundry items of Petty Cash	5	11	1
Balance in the hands of the Bankers, 31st December, 1852	1105	4	0
Balance in the hands of the Secretary, 31st December, 1852	20	9	1
	£6816	0	7

Examined, audited, and found correct, this 20th day of May, 1853.

(Signed) THOMAS KNIGHT, GEORGE I. RAYMOND BARKER, GEORGE DYER, } *Auditors.*

Essays and Reports.—PRIZES FOR 1854.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. FARMING OF DURHAM.

Fifty Sovereigns will be given for the best Report on the Farming of Durham.

1. Geological divisions.
2. Agricultural divisions of soil.
3. Causes of backward condition of agriculture in Durham.
4. Ordinary course of cropping.
5. Improved methods, where such have been practised, should be described.
6. Breed of cattle.
7. Changes, if any, which have taken place since Report of John Bailey, in 1813.
8. Changes required.

II. FARMING OF OXFORDSHIRE.

Fifty Sovereigns will be given for the best Report on the Farming of Oxfordshire.

1. Geological divisions.
2. Agricultural divisions of soil.
3. Usual method of treating the different soils.
4. Best method of treating them, especially the heavy clay-land known as the Oxford clay.
5. Depth and mode of draining which has been found to answer best on the different soils.
6. Injury inflicted by brooks and rivers, with description of remedies which have been or might be applied.
7. Breeds of sheep used in the county.
8. Artificial manures and food purchased.
9. General improvements which have been effected since Report of Arthur Young, in 1809.
10. Improvements still required.

III. FARMING OF DORSETSHIRE.

FIFTY SOVEREIGNS will be given for the best Report on the Farming of Dorsetshire.

1. Geological divisions.
2. Agricultural divisions of soil.
3. Usual method of treating the different soils.
4. Best method of treating them.
5. Depth and mode of draining which has been found to answer best on the different soils.
6. Injury inflicted by brooks and rivers, with description of remedies which have been or might be applied.
7. Breeds of sheep used in the county.
8. Artificial manures and food purchased.
9. Peculiarities of climate.
10. Extent to which downs have been or require to be broken up.
11. General improvements which have been effected since Report of W. Stevenson, in 1815.
12. Improvements still required.

IV. TRUNK DRAINAGE.

FIFTY SOVEREIGNS will be given for the best Account of Trunk or Arterial Drainage.

1. Effect of rivers and brooks in benefiting contiguous grass-land by occasional winter flooding, and injuring it by too long protraction of flood.
2. Injury from summer flooding.
3. Injury by flooding to arable land.
4. Injury by stoppage or prevention of under-drainage.
5. Existing difficulties in the application of a remedy which arise from the claims of mills, navigations, &c.
6. Best and cheapest modes of dealing with the aforesaid claims.
7. Best mode of correcting existing evils, with due regard to preserving the requisite moisture of subsoil in existing meadows and to irrigation.
8. Actual state of some river or rivers to be described.
9. Remedy applied to some river or brook to be described.

V. UNDER-DRAINAGE.

THIRTY SOVEREIGNS will be given for the best Account of Under-Drainage.

1. Kinds of soil and inclinations of surface in which under-drainage by interception of springs is the proper remedy.
2. Depth of such drains.
3. Direction of drains.
4. Mode of filling.
5. Cost of execution.
6. Description of case or cases in which such drains have been successful.
7. Description of cases in which the Parallel System has been found inapplicable.

Parallel Drainage.

8. Depth at which parallel drains should be laid according to the tenacity of the soil and subsoil.
9. Materials with which they should be filled.
10. Dimensions of pipes and cost.
11. Where sockets should be employed.
12. General cost of and return from operation.
13. Best mode of draining running sands.
14. Causes of and remedies for blockage of drains.

VI. GIDDINESS IN SHEEP.

TEN SOVEREIGNS will be given for the best Essay on Giddiness in Sheep generally: discussing the causes of that affection, the remedies for it, and preventives against it.

VII. AUTUMN CLEANING OF STUBBLES.

TEN SOVEREIGNS will be given for the best Essay on the Autumn Cleaning of Stubbles.

1. Forking up couch by hand-labour.
2. Paring land by horse-labour with different implements.
3. Disposal of vegetable matter arising from operation, whether by burning or carting away.
4. Subsequent management of land, if kept bare until turnip-sowing.
5. Subsequent management, if a winter green or other crop be employed.

VIII. SEWAGE MATTER.

TWENTY SOVEREIGNS will be given for the best Essay on the application of Sewage Matter for Agricultural purposes.

1. Best mode of using night-soil from privies, destroying the offensive odour without injuring its fertilising properties.
2. Most profitable method, if any, of applying the matter issuing from common sewers.

IX. AGRICULTURAL WEEDS.

Twenty Sovereigns will be given for the best Essay on Agricultural Weeds.

1. Botanic classification generally of such weeds.
2. Agricultural distinction between annual, deep-rooted, and running weeds.
3. Kinds of soils peculiarly liable to each class of weeds.
4. Best mode of extirpating weeds.

X. ANY OTHER AGRICULTURAL SUBJECT.

Ten Sovereigns will be given for the best Report or Essay on any other Agricultural subject.

The Reports or Essays competing for these Prizes must be sent to the Secretary of the Society, at 12, *Hanover Square, London, on or before March* 1, 1854. *Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsibe for their return.*

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.

6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

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* Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.

Essays and Reports.—AWARDS, 1853.

JOHN DONALDSON, of 4, North Cumming Street, Pentonville; the Prize of TWENTY SOVEREIGNS, for the best Account of the Cultivation and Management of Underwood.

FINLAY DUN, jun., Lecturer on Materia Medica, &c., in the Edinburgh Veterinary College; the Prize of TWENTY SOVEREIGNS, for the best Account of those Diseases in the Horse and the Ox which either are or may become Hereditary.

SYDNEY EVERSHED, of Albury, near Guildford, Surrey; the Prize of TWENTY SOVEREIGNS, for his Essay on the Improved Method of Cropping and Cultivating Light Land.

JOHN B. SPEARING, of Moulsford, near Wallingford, Berkshire; the Prize of THIRTY SOVEREIGNS, for the best Essay on the relative advantages of Steam or other motive power applicable to Agricultural purposes.

THOMAS ROWLANDSON, of Brompton, Middlesex; the Prize of FIFTY SOVEREIGNS, for the best Report on the Farming of Herefordshire.

HENRY EVERSHED, of Albury, near Guildford, Surrey; the Prize of FIFTY SOVEREIGNS, for the best Report on the Farming of Surrey.

JOHN JEPHSON ROWLEY, of Rowthorne, near Chesterfield, Derbyshire; the Prize of FIFTY SOVEREIGNS, for the best Report on the Farming of Derbyshire.

FINLAY DUN, jun., of 41, Heriot Row, Edinburgh; the Prize of TWENTY SOVEREIGNS, for the best Account of those Diseases in the Sheep and the Pig which either are or may become Hereditary.

The Rev. THOMAS BURROUGHES, of Gazeley, near Newmarket; the Prize of TWENTY SOVEREIGNS, for his Essay on the Bean Turnip Fallow.

SUBSTITUTE FOR GUANO.

A THOUSAND POUNDS and the GOLD MEDAL of the Society will be given for the discovery of a Manure equal in fertilising properties to the Peruvian Guano, and of which an unlimited supply can be furnished to the English Farmer at a rate not exceeding *5l.* per ton.—A Committee having been appointed by the Council for deciding on the conditions under which the competition for this prize should take place, their Report will be found given at page iv of this Appendix.

DISCOVERY OF GUANO.

FIFTY SOVEREIGNS will be given for the best Account of the Geographical Distribution of Guano; with suggestions for the discovery of any new source of supply, accompanied by specimens. The Essays competing for *this* Prize are to be sent to the Secretary, at the house of the Society, No. 12, Hanover Square, London, on or before March 1, 1854.

*** These, and all other Prizes offered by the Royal Agricultural Society of England, are open to general competition.

MEMORANDA.

COUNTRY MEETING at Gloucester, on the 13th, 14th, and 15th of July, 1853.

GENERAL MEETING in London, on Saturday, the 10th of December, 1853, at Eleven o'clock A.M.

GENERAL MAY MEETING in London, on Monday, May 22, 1854, at 12 o'clock noon.

COUNTRY MEETING at Lincoln, in 1854.

GENERAL MEETING in London, on the Saturday in the week of the Smithfield Club Show, in December, 1854, at Eleven o'clock A.M.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society.

ADJOURNMENTS.—The Council adjourn over Easter week, and occasionally over Passion and Whitsun weeks; from the first Wednesday in August to that in November; and from the second Wednesday in December to the first Wednesday in February.

GUANO analysed for Members by Professor WAY (at 23, Holles Street, Cavendish Square, London), at 5*s*. for a partial analysis, and at 10*s*. for a complete analysis.—(Journal. vol. XIII., Appendix, p. xxxiv.)

DISEASES of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society, and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(Journal, vol. XI., Appendix, pp. viii, ix; vol. XII., Appendix, p. iv; vol. XIII., Appendix, p. xxxiv; vol. XIV., Appendix, p. v).

LOCAL CHEQUES.

As Local Cheques on Country Bankers are not payable in London, and will not be received as Cash by the Society's Bankers, it is particularly requested that no remittance of them be made on account of payments due to the Society; but that Post-office Orders, made payable in London to the Secretary, or Cheques on London Bankers, should in all cases be sent to him in lieu of such country Cheques.

FARMING ACCOUNTS.

In consequence of the numerous inquiries made at the Society's Office respecting the purchase of the Farm Account-Books recommended by a Committee of the Society (and referred to in the Report of the Council: Journal, Vol. XI., Appendix, pp. ix, x, xi.), the Members of the Society are informed, that they have the privilege of obtaining these Account-Books at a reduced rate, on applying to Messrs. Hallifax and Co., the Stationers of the Society, at 315 Oxford Street, London.

Royal Agricultural Society of England.

1853—1854.

President.

PHILIP PUSEY, Esq., D.C.L.

Trustees.

Acland, Sir Thomas Dyke, Bart., M.P.
Braybrooke, Lord
Challoner, Colonel
Clive, Hon. Robert Henry, M.P.
Graham, Rt. Hon. Sir Jas., Bart., M.P.
Neeld, Joseph, M.P.
Portman, Lord
Pusey, Philip
Richmond, Duke of
Rutland, Duke of
Spencer, Earl
Sutherland, Duke of

Vice-Presidents.

Ashburton, Lord
Barker, Thomas Raymond
Chichester, Earl of
Downshire, Marquis of
Egmont, Earl of
Exeter, Marquis of
Fitzwilliam, Earl
Hardwicke, Earl of
Hill, Viscount
Johnstone, Sir John V. B., Bart., M.P.
Miles, William, M.P.
Yarborough, Earl of

Other Members of Council.

Austen, Colonel
Barnett, Charles
Barrow, William Hodgson, M.P.
Barthropp, Nathaniel George
Beasley, John
Berners, Lord
Blanshard, Henry
Bramston, Thomas William, M.P.
Brandreth, Humphrey
Bridport, Lord
Burke, John French
Camoys, Lord
Cavendish, William George
Denison, John Evelyn, M.P.
Druce, Samuel
Foley, John Hodgetts H., M.P.
Garrett, Richard
Gibbs, B. T. Brandreth
Grantham, Stephen
Hamond, Anthony
Hobbs, William Fisher
Hodges, Thomas Law
Hornsby, Richard
Hudson, John
Jonas, Samuel
Kinder, John
Lawes, John Bennet
Lawrence, Charles
Lemon, Sir Charles, Bart., M.P.
Lucan, Earl of
March, Earl of, M.P.
Melville, Hon. A. Leslie
Milward, Richard
Price, Sir Robert, Bart., M.P.
Ridley, Sir Matthew White, Bart.
Shaw, William
Shelley, Sir John Villiers, Bart., M.P.
Sillifant, John
Simpson, William
Slaney, Robert Aglionby
Smith, Robert
Southampton, Lord
Stansfield, W. R. Crompton
Thompson, Henry Stephen
Turner, Charles Hampden
Turner, George
Vyner, Captain Henry
Webb, Jonas
Wilson, Henry
Woodward, Francis

Secretary.

JAMES HUDSON, 12, *Hanover Square, London.*

Consulting-Chemist—JOHN THOMAS WAY, 23, Holles Street, Cavendish Square.
Veterinary-Inspector—JAMES BEART SIMONDS, Royal Veterinary College.
Consulting-Engineer—JAMES EASTON, or C. E. AMOS, The Grove, Southwark.
Seedsmen—THOMAS GIBBS and Co., Corner of Halfmoon Street, Piccadilly.
Publisher—JOHN MURRAY, 50, Albemarle Street.
Bankers—A. M., C., A. R., H., R., and E. A. DRUMMOND, Charing Cross.

MEMORANDA.

General Meeting in London, on Monday, May 22, 1854, at 12 o'clock noon.

Country Meeting at Lincoln, in the week commencing July 17, 1854.

General Meeting in London, on the Saturday in the week of the Smithfield Club Show, in December, 1854, at Eleven o'clock A.M.

Monthly Council (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

Weekly Council (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society.

Adjournments.—The Council adjourn over Easter week, and occasionally over Passion and Whitsun weeks; from the first Wednesday in August to that in November; and from the second Wednesday in December to the first Wednesday in February.

Guano analysed for Members by Professor Way (at 23, Holles Street, Cavendish Square, London), at 5*s.* for a partial analysis, and at 10*s.* for a complete analysis.—(Journal, vol. XIII., Appendix, p. xxxiv.)

Diseases of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(Journal, vol. XI., Appendix, pp. viii, ix; vol. XII., Appendix, p. iv; vol. XIII., Appendix, p. xxxiv; vol. XIV., Appendix, p. v.)

Prizes.—The subjects, conditions, and regulations for competition of the Society's Prizes for Essays and Reports to be sent in by March 1, 1854, will be found given at length in the Journal, vol. XIV., Appendix, pp. xv—xix; and the terms and conditions of the Prizes of the Society for the discovery of a substitute for Guano, or of a new supply of it, in the same volume of the Journal, Appendix, pp. iv, v, and xix.—The Prize-sheets for Implements and Live-Stock at the Lincoln Meeting will be finally arranged on the 1st of February, 1854. The schedule of Prizes for Cattle, Horses, Sheep, and Pigs on that occasion will be found in the Appendix to the current part of the Journal, p. xxvii.

Local Cheques: requested not to be forwarded for payment in London; but London Cheques, or Post-office Orders, to be sent in lieu of them.

Farming Accounts recommended by a Committee of the Society sold to Members at a reduced rate, by Messrs. Hallifax, 315, Oxford Street, London.

List.—The List of Governors and Members of the Society, intended for insertion in this Appendix, has been unavoidably postponed, from want of space, until the publication of the next part of the Journal.

⁂ Members may obtain on application to the Secretary copies of Abstract of the Charter and the Bye-Laws, of a Statement of the General Objects, &c. of the Society, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING:

12, Hanover Square, Saturday, December 10, 1853.

REPORT OF THE COUNCIL.

The Council have to report to the Members at their present General Meeting that during the past half-year the Society has lost, by deaths or resignations, 43 of its Members, while 156 new Members have, during the same period, been enrolled on its list, which is now constituted as follows:—

88 Life Governors,
148 Annual Governors,
760 Life Members,
4073 Annual Members, and
20 Honorary Members.

The Council have elected Lord Ashburton to supply the vacancy in the number of the Vice-Presidents occasioned by the deeply-lamented death of the Earl Ducie; and the Hon. A. Leslie Melville of Lincolnshire, Mr. Barthropp of Suffolk, and Lord Bridport, as General Members of Council, in the place respectively of Lord Ashburton, Professor Sewell, and Mr. Bennett.

A new list of the Governors and Members of the Society having been prepared for insertion in the ensuing number of the Journal, the Council submit to the members on this occasion the following schedule, showing their distribution throughout the kingdom:—

SCHEDULE OF DISTRIBUTION AND REPRESENTATION.

	Number of Members.		Amount of Representation in the Council.	
ENGLAND:—				
Beds	48		2	
Berks	117		4	
Bucks	66		2	
Cambridge	58		3	
Cheshire	56		0	
Cornwall	61		1	
Cumberland	43		1	
Derby	93		0	
Devon	208		4	
Dorset	109		1	
Durham	96		0	
Essex	142		4	
Gloucester	134		3	
Hants (including Isle of Wight)	164		1	
Hereford	100		1	
Herts	114		3	
Hunts	36		0	
Kent	183		2	
Lancaster	156		0	
Leicester	71		2	
Lincoln	174		4	
Middlesex	266		7	
Monmouth	27		0	
Norfolk	256		3	
Northampton	100		4	
Northumberland	138		1	
Notts	101		3	
Oxon	112		3	
Rutland	7		0	
Salop	176		3	
Somerset	187		2	
Staffs	137		1	
Suffolk	126		3	
Surrey	135		2	
Sussex	186		6	
Warwick	76		0	
Westmoreland	25		0	
Wilts	96		2	
Worcester	66		3	
York	229		5	
Total	—	4676	—	86
WALES:—				
Anglesea	6		0	
Brecon	29		0	
Carmarthen	36		0	
Carnarvon	7		0	
Cardigan	16		0	
Denbigh	18		0	
Flint	24		0	
Glamorgan	66		0	
Merioneth	2		0	
Montgomery	14		0	
Pembroke	32		0	
Radnor	6		0	
Total	—	256	—	0
SCOTLAND		69		2
IRELAND		44		2
CHANNEL ISLANDS and ISLE OF MAN		15		0
(Abroad)		29		0
General Total		5089		90

The Council consists of 75 Members, several of whom represent by their residences more than a single county.

This schedule will enable those friends of the Society, and of agricultural improvement generally, who reside in districts where the number of members is below the average, to ascertain the cause and possibly remedy the evil; while it will afford an opportunity to the Council, of recommending to the Society the election from time to time of such representatives of large bodies of members, at present unrepresented, particularly in the case of Lancashire and the Principality of Wales, as may best promote the agriculture of the particular district and advance the general objects of the Society: the Council being most anxious that their body should be brought as nearly as possible to represent by its members the varied wants and wishes of the agricultural community.

The advantages already gained to the individual members and the country at large by the aggregate amount of single subscriptions from numbers contributed to the Society, are such as to induce the hope of a still further augmentation of its subscribers in different parts of the country; while the improved facilities of communication afford every opportunity by which payments may be made, information sought or transmitted, and Journals delivered free to the members at their own homes in the ordinary course of the post: the railways furnishing rapid means of transit for passengers, live stock, and implements from every part of the kingdom, to the place where the annual country meeting may successively be held. The funds thus accruing to the Society from so large a body of paying members will enable it to carry out those extended measures of public utility which it would otherwise be unable to accomplish, and the personal exertions and the practical experience brought into co-operation with the Society by their means will confer incalculable benefit on its proceedings.

The Finances of the Society continue to receive the most vigilant attention of the Council, and they feel it their duty, under circumstances however apparently pressing at the moment, to guard their invested capital derived from life-compositions,

as the sheet-anchor of the Society. The floating cash-balance available for current purposes is constantly in a state of fluctuation, from various causes, either connected with irregularity in the remittance of subscription, or from extraordinary demands arising chiefly out of the proceedings of the Country Meetings.

The country generally is well aware of the great service the Society has rendered, in having raised up, by its prizes on the one hand and its most effective tests on the other, a new body of agricultural implement-makers, whose talent and workmanship now attract general attention. The Council have spared no outlay of money, nor their members either personal zeal or anxiety, to attain this great object; and having attained it, they feel it their duty to devise means by which the same results may be maintained at a less amount of annual expenditure. They have therefore caused a detailed statement to be prepared, for the information of the members, of the expenses connected with every branch of the Society's country meetings: this has already been completed in the case of the Lewes Meeting, and will be inserted in the ensuing part of the Journal.

The Gloucester Meeting, notwithstanding the very unfavourable state of the weather on the principal day of the show, fully satisfied the expectations of the Council. The authorities of the city, the local committee, and the owners and occupiers of sites, contributed zealously to promote the objects of the Society on the occasion, and received at the time the public thanks of the Members at their General Meeting, held in the County Hall. The Society were again indebted to the liberality of the railway companies, in the conveyance of implements and live stock, and in their general arrangements for the convenience of the visitors. The senior-stewards of implements and live stock have drawn up reports connected with their respective departments, for publication in the Society's Journal.

The Council have decided on the following Schedule of Cattle Prizes, to be offered by the Society at the Lincoln Meeting, in the week commencing Monday the 17th of July next:—

	£.
Shorthorns	180
Herefords	180
Devons	180
Other breeds	70
Horses	165
Leicesters	120
Southdowns (or other short-woolled Sheep)	120
Long-woolled Sheep (not Leicesters)	120
Improved Lincoln Sheep	50
Pigs	80
	1265

The prizes for implements and for poultry will be decided on the reports of respective Committees, on the 1st of February next, when the conditions and general regulations of the Prize-sheets will be finally arranged.

Professor Way, the consulting chemist of the Society, delivered before the Members, in June last, a lecture on the management of the sewerage-matter of towns as manure for agricultural purposes; and Professor Simonds, the veterinary inspector of the Society, is continuing his researches into the cause and treatment of diseases occurring among the live stock of the farmer.

The Council witness with much satisfaction the steady support which the Society receives in the acquisition of new Members and zealous co-operators, the lively interest created in the districts assigned for the successive Country Meetings, and the increasing intelligence which distinguishes the agricultural community of the country. Science is no longer regarded as an unattainable acquirement, but has become an active principle, which, like the magnetic needle, points out the course to be steered, when all around is dark and uncertain: it has, indeed, been found to be *that* knowledge which is power.

By order of the Council,

JAMES HUDSON,
Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account, ending the 30th of June, 1853.

Receipts.

	£.	s.	d.
Balance in the hands of the Bankers, 1st January, 1853	1105	4	0
Balance of Petty Cash in the hands of the Secretary, 1st January, 1853	20	9	1
Dividends on Stock	157	12	3
Life-Compositions of Members	350	0	0
Annual Subscriptions of Governors	530	0	0
Annual Subscriptions of Members	2422	9	0
Receipts on account of Journal	163	9	3
Receipts on account of Cottage Tracts	2	4	11
Receipts on account of Country Meetings	1526	15	0
Cheque for Petty Cash drawn, but not cashed	50	0	0
	£6328	3	6

Payments.

	£.	s.	d.
Purchase of stock (773*l.* 17*s.* 7*d.* in the $3\frac{1}{4}$ per Cents.)	800	0	0
Permanent Charges	170	12	6
Taxes and Rates	13	19	5
Establishment	481	1	3
Postage and Carriage	28	9	4
Advertisements	4	15	0
Payments on account of Journal	703	15	1
Veterinary Grant (one year and a half)	300	0	0
Veterinary Investigations (half a year)	55	13	0
Chemical Grant (half a year)	100	0	0
Chemical Investigations (one-third of a year)	100	0	0
Prizes	414	15	0
Payments on account of Country Meetings	863	1	11
Sundry items of Petty Cash	2	18	10
Balance in the hands of the Bankers, 30th June, 1853	2249	15	11
Balance of Petty Cash in the hands of the Secretary, 30th June, 1853	39	6	3
	£6328	3	6

(Signed) THOMAS RAYMOND BARKER, *Chairman.*
C. B. CHALLONER.
HENRY BLANSHARD.
SAMUEL JONAS.
} *Finance Committee.*

Examined, audited, and found correct, this 9th day of December, 1853.
(Signed) THOMAS KNIGHT.
GEORGE I. RAYMOND BARKER.
GEORGE DYER.
} *Auditors.*

DETAILED STATEMENT OF COUNTRY MEETING ACCOUNT.—*Lewes*, 1852.

RECEIPTS.

	£.	s.	d.
Subscription from the Town and Neighbourhood of Lewes	1500	0	0
One-half of the Implement Shedding paid for by Exhibitors	218	17	0
Non-Members' Fees for the entry of Implements	17	1	0
Non-Members' Fees for the Entry of Live Stock	78	18	6
Admissions to the Show of Implements on the first day	104	7	6
Admissions to the Show of Live Stock on the first day	107	15	0
Admissions to the Show of Implements and Live Stock on the remaining days	972	7	10
Sale of Catalogues of the Implements	54	4	0
Sale of Catalogues of the Live Stock	116	15	0
Sale of Wheat, Oats, Chaff, &c. &c.	77	16	0
Fines received for the Non-exhibition of Implements	14	10	0
Fines received for the Non-exhibition of Live Stock	14	0	0
Sale of 413 Pavilion Dinner Tickets at 10*s*. each	206	10	0
Sale of Badges to the Council	2	0	0
Total Receipts	£3485	1	10

(Signed) C. B. CHALLONER.
THOS. RAYMOND BARKER.
HENRY WILSON.
HENRY BLANSHARD.
SAMUEL JONAS.

DETAILED STATEMENT OF

PAYMENTS.

Implements.

		£. s. d.	£. s. d.
Henry Manning	Contract for the Fence, Sheds, &c. &c., of the Implement-Yard	841 7 8	
	Increase of Shedding for the Implements	21 2 0	
	Extras in the Implement-Yard and the Trial-Yard	36 3 0	
Staff of the Implement-Yard	Foremen of the Implement-Yard	21 12 0	
	Yardmen in the Implement-Yard	89 17 0	
	Superintendent and Sellers of Implement Catalogues	6 0 0	
	Money-takers and Door-keepers	13 7 9	
	Director's Clerks and Assistants	10 3 0	
Ellman	Wheat and Rye Crops	122 0 0	
Stunt	Oats	13 0 0	
Smart	Beans	1 9 0	
Elphick	Cake, &c.	8 15 6	
Saxby	Soft Soap	1 12 0	
Davey	Clay	2 1 6	
Thompson	Ironmongery	3 6 9	
Edgington	Tar Twine	2 17 11	
Horne	Coals	10 0 0	
Davey	Sacks	8 12 0	
Browne	Flax	4 14 0	
Peters	Horses and Men for the Trials	128 4 0	
Crosskill	Trucks	36 10 0	
Use of Engines	Of Messrs. Batley, Tuxford, Clayton, and Barrett	21 19 0	
Smith	Engineer, for attendance on Steam-Engines	5 5 0	
Consulting Engineer	Time and Expenses of Consulting Engineer and Assistants	85 13 10	
	Expenses connected with the Testing Machines	63 9 8	
	Railway Carriage of Break	9 4 7	
Judges	Allowance to the 10 Implement Judges	172 0 0	
	Cost of Badges for the Implement Judges	1 4 6	
Henry Holt	Refreshments for the Implement Judges and Stewards	62 4 8	
Printing	Rogerson—Implement Catalogue	167 16 0	
	Rogerson—General Account for the Implement Show	41 9 3	
	Clowes—Implement Prize Sheets	13 15 0	
	Baxter—Implement Awards	8 0 0	
Advertising	The Implement Prize Sheet	45 4 3	
Stationery	For the Implement-Yard	8 10 7	
Postage	On account of the Implement Show	12 10 0	
Petty Payments	Made by the Honorary Director	4 13 0	
			2105 14 5

Live Stock.

		£. s. d.	£. s. d.
Henry Manning	Contract for the Fence, Sheds, &c. &c., of the Cattle-Yard	490 8 4	
	Increase of Shedding for the Cattle and Poultry	273 13 3	
	Extras in the Cattle-Yard	40 3 0	
	Hire of Hurdles	116 13 4	
Staff of the Cattle Yard	Foremen of the Yard for Cattle and Poultry	22 2 0	
	Yardmen in the Cattle-Yard	89 17 0	
	Superintendent and Sellers of Live Stock Catalogues	6 1 6	
	Money-takers and Door-keepers	9 3 9	
	Honorary Director's Clerks and Assistants	11 0 0	
Ellman	Green Food	134 0 0	
Pannett	Hay and Straw	68 1 10	
Mapplebeck	Poultry Cages	7 0 1	
Marchant	Tin numbers	2 3 6	
Shoosmith	Cartage	1 7 6	
Judges	Allowance to 30 Judges of Live Stock at 8*l.* each	240 0 0	
	Cost of Badges for the Judges of Live Stock	2 5 0	
Veterinary Inspect.	Allowance to Professor Simonds, the Veterinary Inspector	12 0 0	
Henry Holt	Refreshments for the Judges and Stewards of Live Stock	30 0 0	
Printing	Rogerson—Catalogue of Live Stock	59 8 0	
	Rogerson—General Account for the Show of Live Stock	79 1 3	
	Baxter—Awards of Live Stock	25 0 0	
Advertising	The Prize Sheet for Live Stock	55 2 0	
Stationery	For the Show of Live Stock	8 10 7	
Postage	On account of the Show of Live Stock	12 10 0	
Petty Payments	Made by the Honorary Director	4 12 11	
			1800 4 10
	Amount carried up		£3905 19 3

COUNTRY MEETING ACCOUNT—*continued.*

PAYMENTS.

		£. s. d.	£. s. d.
Amount brought up			3905 19 3

Pavilion Dinner.

		£. s. d.	£. s. d.
Henry Manning	Contract for the erection of the Pavilion	540 0 0	
	Erection of Sheds for the Contractor for the Dinner	25 0 0	
	Erection of a temporary room for the High Table Guests	4 15 0	
	Iron Standards for holding the distinguishing Letters of the Tables	1 18 0	
	Wands for the Stewards	0 7 0	
Henry Holt	Contract for the Dinner	340 0 0	
	Luncheon for Stewards	0 8 6	
Printing	Rogerson—Tenders and Toasts	1 7 6	
	Halfhide—Invitation Cards	1 0 0	
	Dorrington—Distinguishing Letters for the Tables	2 10 0	
	Whiting—Dinner Tickets	4 10 0	
	Bacon—Lists of Toasts	1 5 0	
Trumpeters	Paid the two Trumpeters	2 2 0	
Toastmaster	Paid the Toastmaster	1 1 0	
Advertising	For Contracts for the Dinner	4 13 0	
Postage	Connected with the Dinner	0 11 0	
			931 8 0

Miscellaneous.

		£. s. d.	£. s. d.
Police	Expense of the London Police for the Meeting generally	94 10 0	
Printing	Rogerson—Programmes, &c. &c.	23 19 6	
	Baxter—Posters for directions to the Offices, &c.	1 10 0	
Offices	Manning—For the erection of the Temporary Council Room and Offices	25 0 0	
Advertising	General advertising of the Programme	51 17 0	
Staff	Board and Lodging of the Secretary and Clerks	10 5 0	
	Travelling Expenses of the Secretary and Clerks	6 14 8	
	Extra Clerk	1 3 0	
	Messenger	0 10 0	
Stationery	Hallifax—Stationery for the Meeting generally	1 8 6	
	Baxter—Stationery for the Meeting generally	0 7 0	
Lecture	Professor Simonds—For Diagrams, &c.	4 7 6	
	Whiting—Printing the Lecture Tickets	1 0 0	
	Henry Manning—For Carpenter's attendance on Lecturer	0 7 0	
Badges	For the Council and Stewards	2 9 6	
Surveyor's Plans.	Henry Manning—For preparing Working Plans of the Show-Yards, &c.	2 2 0	
Petty Payments	A Bill-sticker	0 12 0	
	Henry Wright—Loss on Catalogues sold in London after the Meeting	0 7 4	
	Newspapers for the Society's Files	0 2 11	
			228 12 11
	Total Payments		£5066 0 2

	£. s. d.
Excess of Payments over Receipts on account of the Lewes Meeting chargeable to the General Funds of the Society	1580 18 4
Prizes for Implements and Live Stock, awarded at the Lewes Meeting	1636 15 0
General Balance against the Society on account of the Lewes Meeting	£3217 13 4

Country Meeting at Gloucester.

JULY 13—15, 1853.

JUDGES.

SHORT HORNS.	JOHN GREY	Dilston, Northumberland.
	CHARLES STOKES	Kingston upon Soar, Nottinghamshire.
	JOHN WRIGHT	Chesterfield, Derbyshire.
HEREFORDS.	WILLIAM COX	Scotsgrove, Buckinghamshire.
	THOMAS HARTSHORNE	Brancote, Staffordshire.
	JOHN WILLIAMS	Kingsland, Herefordshire.
DEVONS.	EDWARD L. FRANKLIN	Ascott, Oxfordshire.
	PHILIP HALSE	Molland, Devonshire.
	HENRY TRETHEWY	Grampound, Cornwall.
WELSH AND OTHER BREEDS.	EDWARD L. FRANKLIN	Ascott, Oxfordshire.
	THOMAS HUNT	Thornington, Northumberland.
	JOHN EDWARD JONES	Breinton, Herefordshire.
HORSES.	THOMAS BOOT COLTON	Eagle Hall, Lincolnshire.
	WILLIAM LINTON	Sherriff Hutton, Yorkshire.
	WILLIAM C. SPOONER	Eling, Hampshire.
LEICESTER SHEEP.	HUGH AYLMER	West Dereham, Norfolk.
	SAMUEL BENNETT	Bickering's Park, Bedfordshire.
	HENRY CHAMBERLAIN	Desford, Leicestershire.
SOUTH-DOWN OR OTHER SHORT-WOOLLED SHEEP.	EDWARD POPE	Great Toller, Dorsetshire.
	EDWARD TRUMPER	Newnham, Oxfordshire.
	JOHN WATERS	Eastbourne, Sussex.
LONG-WOOLLED SHEEP.	JOHN ABBOTT	Ospringe, Kent.
	CHARLES CLARKE	Bracebridge, Lincolnshire.
	NATHANIEL C. STONE	Rowley Fields, Leicestershire.
PIGS.	JOHN CLAYDEN	Littlebury, Essex.
	HENRY EDDISON	Gateford, Nottinghamshire.
	WILLIAM HESSELTINE	Worlaby, Lincolnshire.
POULTRY.	JOHN BAILY	Mount Street, London.
	WILLIAM TORR	Aylesby Manor, Lincolnshire.
	THOMAS BARBER WRIGHT	Great Barr, Staffordshire.
SHROPSHIRE OR OTHER GREY AND BLACK-FACED SHORT-WOOLLED SHEEP.	WILLIAM COX	Scotsgrove, Buckinghamshire.
	THOMAS HARTSHORNE	Brancote, Staffordshire.
	JOHN WILLIAMS	Kingsland, Herefordshire.
IMPLEMENTS.	JOSEPH DRUCE	Eynsham, Oxfordshire.
	JOHN V. GOOCH	Stratford, Essex.
	THOMAS WILLIAM GRANGER	Stretham, Cambridgeshire.
	HENRY JOHN HANNAM	Burcot, Oxfordshire.
	WILLIAM LISTER	Dunsa Banks, Yorkshire.
	JAMES HALE NALDER	Alvescote, Gloucestershire.
	WILLIAM OWEN	Rotherham, Yorkshire.
	JOHN JEPHSON ROWLEY	Rowthorne, Derbyshire.
	THOMAS SCOTT	Broom Close, Yorkshire.
	WILLIAM SHAW	Far Coton, Northamptonshire.
	OWEN WALLIS	Overstone Grange, Northamptonshire.
	WILLIAM WOODWARD	Bredon's Norton, Gloucestershire.

VETERINARY INSPECTOR,

AND REFEREE TO THE JUDGES OF LIVE STOCK.

PROFESSOR SIMONDS.........Royal Veterinary College, London.

CONSULTING ENGINEER,

AND REFEREE TO THE JUDGES OF IMPLEMENTS.

CHARLES EDWARDS AMOS ....Grove, Southwark, Surrey.

AWARD OF PRIZES.

CATTLE: *Short-Horns.*

LORD BERNERS, of Keythorpe Hall, Tugby, Leicestershire: the Prize of FORTY SOVEREIGNS, for his 2 years and 3 months-old Roan Short-horned Bull "Pat," bred by himself.

RICHARD STRATTON, of Broad Hinton, near Swindon, Wiltshire: the Prize of TWENTY SOVEREIGNS, for his 3 years and 6 months-old Roan Short-horned Bull "Clarendon;" bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton, Yorkshire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year 9 months and 13 days-old White Short-horned Bull "Windsor;" bred by himself.

WILLIAM FLETCHER, of Radmanthwaite, near Mansfield, Nottinghamshire: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 4 months-old Roan Short-horned Bull "Champion;" bred by himself.

HENRY SMITH, of the Grove, Cropwell Butler, Nottinghamshire: the Prize of TWENTY SOVEREIGNS, for his 4 years 3 months and 20 days-old Roan Short-horned In-milk and In-calf Cow "Vellum;" bred by Sir Charles Tempest, Bart., of Broughton Hall, Skipton, Yorkshire.

RICHARD BOOTH, of Warlaby, near Northallerton, Yorkshire: the Prize of TEN SOVEREIGNS, for his 5 years 1 month and 16 days-old Roan Short-horned In-milk and In-calf Cow "Rose Blossom;" bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton, Yorkshire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 5 months-old Roan Short-horned In-calf Heifer "Bridesmaid;" bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton, Yorkshire: the Prize of TEN SOVEREIGNS, for his 2 years 9 months and 17 days-old Roan Short-horned In-calf Heifer "Peach Blossom;" bred by himself.

BENJAMIN HAIGH ALLEN, of Longcrofts Hall, near Lichfield, Staffordshire: the Prize of TEN SOVEREIGNS, for his 1 year and 8 months-old White Short-horned yearling Heifer "Iris;" bred by John Renton, of Farnley, near Otley, Yorkshire.

RICHARD STRATTON, of Broad Hinton, near Swindon, Wiltshire: the Prize of FIVE SOVEREIGNS, for his 1 year and 5 months-old Roan Short-horned yearling Heifer "Mantle;" bred by himself.

CATTLE: *Herefords.*

LORD BERWICK, of Cronkhill, near Shrewsbury: the Prize of FORTY SOVEREIGNS, for his 3 years 6 months and 2 days-old Red with White face Hereford Bull "Albert Edward;" bred by himself.

JOHN CARWARDINE, of Stockton Bury, near Leominster, Herefordshire: the Prize of TWENTY SOVEREIGNS, for his 2 years 6 months and 12 days-old Dark Brown Hereford Bull "Malcolm;" bred by the late John Turner, of Court of Noke, near Pembridge, Herefordshire.

EDWARD PRICE, of Courthouse, near Leominster, Herefordshire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 10 months-old Red and White Hereford Bull "Magnet;" bred by Thomas Yeld, of The Broom, near Leominster, Herefordshire.

LORD BERWICK, of Cronkhill, near Shrewsbury: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 7 months and 22 days-old dark Red with white face Hereford Bull "Truant;" bred by himself.

JOHN MONKHOUSE, of The Stow, near Hereford: the Prize of TWENTY SOVEREIGNS, for his 8 years and 8 months-old Red with white face Hereford In-calf Cow "Winifred;" bred by James Rea, of Monaughty, near Knighton, Radnorshire.

JAMES ACKERS, of Prinknash Park, near Painswick, Gloucestershire: the Prize of TEN SOVEREIGNS, for his 3 years 8 months and 21 days-old Dark Brown with white face Hereford In-milk and In-calf Cow "Beauty;" bred by himself.

LORD BERWICK, of Cronkhill, near Shrewsbury: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 6 months and 18 days-old Red with spotted face Hereford In-calf Heifer "Miss Lewes;" bred by himself.

PHILIP TURNER, of The Leen, near Pembridge, Herefordshire: the Prize of TEN SOVEREIGNS, for his 2 years and 6 months old Red with white face Hereford In-calf Heifer "Nell Gwynne;" bred by himself.

EDWARD PRICE, of Courthouse, near Pembridge, Herefordshire: the Prize of TEN SOVEREIGNS, for his 1 year and 5 months-old Red and White Hereford yearling Heifer; bred by himself.

CATTLE: *Devons.*

GEORGE TURNER, of Barton, near Exeter: the Prize of FORTY SOVEREIGNS, for his 2 years 8 months and 14 days-old Red Devon Bull "Duke of Devon;" bred by himself.

ROBERT WRIGHT, of Moor Farm, near Taunton, Somersetshire: the Prize of TWENTY SOVEREIGNS, for his 3 years and 5 months-old Red Devon Bull "Young Miracle;" bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 4 months-old Red Devon Bull "Abd el Kader;" bred by Richard Mogridge, of Molland, Devon.

SAMUEL FARTHING, of Stowey Court, near Bridgewater, Somersetshire: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 6 months-old Red Devon Bull "Prince;" bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of TWENTY SOVEREIGNS, for his 4 years 3 months and 14 days-old Red Devon In-milk and In-calf Cow "Lady;" bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of TEN SOVEREIGNS, for his 4 years and 8 months-old Red Devon In-milk and In-calf Cow "Wallflower;" bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 7 months-old Red Devon In-calf Heifer "Verbenum;" bred by himself.

JAMES HOLE, of Knowle House, near Dunster, Somersetshire: the Prize of TEN SOVEREIGNS, for his 2 years and 8 months-old Red Devon In-calf Heifer (not named); bred by himself.

JAMES QUARTLY, of Molland House, near South Molton, Devonshire: the Prize of TEN SOVEREIGNS, for his 1 year 6 months and 21 days-old Red Devon yearling Heifer "Sylph;" bred by himself.

JAMES QUARTLY, of Molland House, near South Molton, Devonshire: the Prize of FIVE SOVEREIGNS, for his 1 year 6 months and 21 days-old Red Devon yearling Heifer "Primrose;" bred by himself.

CATTLE: *Welsh Breed.*

[No entry was made for the Prizes of Twenty Sovereigns, and Ten Sovereigns, offered by the Society for the best and second best Bulls of the Welsh breed calved previously to the 1st July, 1851, and not exceeding four years old.]

WILLIAM POWELL, of Eglwysnunydd, near Margam Taibach, Glamorganshire: the Prize of TEN SOVEREIGNS, for his 1 year and 8 months-old Dark Brown and White Welsh Bull "Prince;" bred by himself.

WILLIAM POWELL, of Eglwysnunydd, near Margam Taibach, Glamorganshire: the Prize of TEN SOVEREIGNS, for his 5 years and 4 months-old Black and White Welsh In-milk and In-calf Cow "Pretty;" bred by himself.

George Goode, of Croft Cottage, near Carmarthen: the Prize of Five Sovereigns, for his 6 years and 5 months-old Black Welsh In-milk Cow "Judy;" bred by himself.

William Powell, of Eglwysnunydd, near Margam Taibach, Glamorganshire: the Prize of Ten Sovereigns, for his 2 years and 8 months-old Brown and White Welsh In-calf Heifer "Spot;" bred by himself.

George Goode, of Croft Cottage, near Carmarthen: the Prize of Five Sovereigns, for his 1 year 4 months and 10 days-old Black Welsh yearling Heifer "Beauty;" bred by himself.

Cattle: *Other Breeds* (not qualified to compete as Short-horns, Herefords, Devons, or Welsh).

Nathaniel George Barthropp, of Cretingham Rookery, near Woodbridge, Suffolk: the Prize of Ten Sovereigns, for his 3 years and 1 month-old Red Suffolk Bull "Oakley;" bred by the late Sir Edward Kerrison, Bart., then of Oakley Park, Suffolk.

Samuel Burbery, of Wroxhall, near Warwick: the Prize of Ten Sovereigns, for his 1 year and 5 months-old Red and White Long-horned Bull "Lumber;" bred by himself.

Capt. William Inge, of Thorpe, near Tamworth, Staffordshire: the Prize of Ten Sovereigns, for his 11 years 5 months and 7 days-old Red and White Long-horned In-milk Cow "Daisy;" bred by himself.

Edward Cane, of Berwick Court, near Lewes, Sussex: the Prize of Five Sovereigns, for his 2 years and 4 months-old Red Sussex In-calf Heifer (not named); bred by himself.

William Cornwallis Cartwright, of Aynhoe Park, near Brackley, Northamptonshire: the Prize of Five Sovereigns, for his 1 year 5 months and 14 days-old Black Angus polled yearling Heifer (not named); bred by himself.

Horses.

Samuel Clayden, of Little Linton, near Linton, Cambridgeshire: the Prize of Thirty Sovereigns, for his 4 years-old Chesnut Suffolk Agricultural Stallion "Samson;" bred by himelf.

William Wilson, of Ashbocking, near Ipswich, Suffolk: the Prize of Fifteen Sovereigns, for his 6 years-old Chesnut True Suffolk Agricultural Stallion "Goliah;" bred by Samuel Ling, of Olly Hall, near Ipswich, Suffolk.

John Ward, of East Mersea, near Colchester, Essex: the Prize of Twenty Sovereigns, for his 2 years-old chesnut Suffolk Agricultural Stallion "Colonel;" bred by the late Henry Parsons, then of Stoke-by-Nayland, Essex.

George Sexton, of Thorrington Hall, Wherstead, near Ipswich, Suffolk: the Prize of Ten Sovereigns, for his 2 years-old Chesnut Pure Suffolk Agricultural Stallion "Prince;" bred by Daniel Lee, of Felixstow, Suffolk.

John Lister, of Addingham, near Otley, Yorkshire: the Prize of Fifteen Sovereigns, for his 5 years and 5 months-old Bright Bay Half-bred Roadster Stallion "Young Merry Legs;" bred by himself.

William Bateman Reed, of Albert Lodge, Clifton, Somersetshire: the Prize of Ten Sovereigns, for his 13 years-old Chesnut and White Welsh Stallion Pony "Jack;" breeder unknown.

Henry Bailey, of Wolgaston Farm, near Berkeley, Gloucestershire: the Prize of Twenty Sovereigns, for his 7 years-old Dark Brown Agricultural Mare "Dimont" and Foal; bred by himself.

Thomas Beale Browne, of Hampen, near Andoversford, Gloucestershire: the Prize of Ten Sovereigns, for his 7 years-old chesnut Suffolk Agricultural Mare "Smiler" and Foal; bred by John Green, of Newton Hall, near Sudbury, Suffolk.

William Bateman Reed, of Albert Lodge, Clifton, Somersetshire: the Prize of Five Sovereigns, for his 4 years-old Black Welsh Mare Pony "Fanny;" bred by James Ryall and William B. Reed, at Westbury-on-Trym, near Bristol.

Thomas Beale Browne, of Hampen, near Andoversford, Gloucestershire: the Prize of Fifteen Sovereigns, for his 2 years-old Chesnut Suffolk Agricultural Filly "Bonny;" bred by John Reed, of Laxfield, Suffolk.

James Elgar Owen, of Hodcott, West Ilsley, Berkshire: the Prize of Five Sovereigns, for his 2 years and 1 month-old Bay and Black Agricultural Filly "Ventor;" bred by himself.

Sheep: *Leicesters.*

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Thirty Sovereigns, for his 16 months-old Leicester Shearling Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Sandy, Bedfordshire: the Prize of Fifteen Sovereigns, for his 16 months-old Leicester Shearling Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Sandy, Bedfordshire: the Prize of Thirty Sovereigns, for his 28 months-old Leicester Ram; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Fifteen Sovereigns, for his 40 months-old Leicester Ram; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Ten Sovereigns, for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

Sheep: *Southdown or other Short-wools.*

Jonas Webb, of Babraham, near Cambridge: the Prize of Thirty Sovereigns, for his 16 months-old Southdown Shearling Ram; bred by himself.

Jonas Webb, of Babraham, near Cambridge: the Prize of Fifteen Sovereigns, for his 17 months-old Southdown Shearling Ram; bred by himself.

Henry Lugar, of Hengrave, near Bury St. Edmunds, Suffolk: the Prize of Thirty Sovereigns, for his 28 months-old Southdown Ram "Number One;" bred by himself.

William Rigden, of Hove, near Brighton, Sussex: the Prize of Fifteen Sovereigns, for his 40 months-old Southdown Ram; bred by himself.

Henry Lugar, of Hengrave, near Bury St. Edmunds, Suffolk: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

Henry Lugar, of Hengrave, near Bury St. Edmunds, Suffolk: the Prize of Ten Sovereigns, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

Sheep: *Long Wools* (not qualified to compete as Leicesters).

William Lane, of Broadfield Farm, Eastington, near Northleach, Gloucestershire: the Prize of Thirty Sovereigns, for his 16 months-old Cotswold Shearling Ram; bred by himself.

William Garne, of Aldsworth, near Northleach, Gloucestershire: the Prize of Fifteen Sovereigns, for his 16 months-old Cotswold Shearling Ram; bred by himself.

William Slatter, of Stratton, near Cirencester: the Prize of Thirty Sovereigns, for his 28 months-old Cotswold Ram; bred by himself.

Edward Handy, of Sevenhampton, near Andoversford, Gloucestershire: the Prize of Fifteen Sovereigns, for his 40 months-old improved Cotswold Ram; bred by Charge Large, of Broadwell, near Lechlade, Gloucestersh.

WILLIAM LANE, of Broadfield Farm, Eastington, near Northleach, Gloucestershire: the Prize of TWENTY SOVEREIGNS, for his pen of five 16 months-old Cotswold Shearling Ewes; bred by himself.

WILLIAM LANE, of Broadfield Farm, Eastington, near Northleach, Gloucestershire: the Prize of TEN SOVEREIGNS, for his pen of five 16 months-old Cotswold Shearling Ewes; bred by himself.

SHEEP: *Shropshire or other Grey and Blackfaced Short Wools.*

[Special Prizes offered by the Hon. Robert Henry Clive, M.P.]

JOHN GILLETT, of Brize Norton, near Witney, Oxfordshire: the Prize of TWENTY SOVEREIGNS, for his 41 months-old Blackfaced Shortwoolled Ram; bred by himself.

THOMAS HORTON, of Harnage Grange, Cressage, near Shrewsbury, Shropshire: the Prize of TEN SOVEREIGNS, for his 28 months-old Shropshire Shortwoolled Ram; bred by himself.

WILLIAM FOSTER, of Kinver Hill Farm, near Stourbridge, Worcestershire: the Prize of TEN SOVEREIGNS, for his pen of five 76½ months and 64½ months-old Shropshire Shortwoolled Ewes, with their Lambs; bred by himself.

WILLIAM FOSTER, of Kinver Hill Farm, near Stourbridge, Worcestershire: the Prize of TEN SOVEREIGNS, for his pen of five 16 months-old Shropshire Shortwoolled Shearling Ewes; bred by himself.

PIGS.

ROBERT CROSSLEY, of Holland Street, Miles Platting, Newton, near Manchester, Lancashire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 4 months and 6 days-old white with blue spots pure Lancashire Boar of a large breed "Sir William Wallace;" bred by himself.

THOMAS HORSFALL, of Burley Hall, near Otley, Yorkshire: the Prize of FIVE SOVEREIGNS, for his 2 years 10 months and 1 week-old white Yorkshire Boar of a large breed "Hector;" bred by himself.

WILLIAM NORTHEY, of Lake, near Lifton, Devonshire: the Prize of FIFTEEN SOVEREIGNS, for his 11 months and 1 week-old black improved Leicester Boar, of a small breed; bred by himself.

JOHN MOON, of Lapford, near Crediton, Devonshire: the Prize of FIVE SOVEREIGNS, for his 1 year and 5 months-old black Essex Boar of a small breed; bred by William Fisher Hobbs, of Boxted Lodge, near Colchester, Essex.

THOMAS CRAVEN, of Whetley Street, Manningham, near Bradford, Yorkshire: the Prize of TEN SOVEREIGNS, for his 3 years 5 months and 2 weeks-old white and blue breeding Sow of a large breed "Victoria;" breeder unknown.

JOHN MOON, of Lapford, near Crediton, Devonshire: the Prize of TEN SOVEREIGNS, for his 7 months-old black improved Essex breeding Sow of a small breed; bred by himself.

WILLIAM JAMES SADLER, of Bentham, near Purton, Wiltshire: the Prize of TEN SOVEREIGNS, for his pen of three 7 months and 3 weeks-old dark and white Berkshire breeding Sow Pigs of a large breed; bred by himself.

LORD WENLOCK, of Escrick Park, near York: the Prize of TEN SOVEREIGNS, for his pen of three 7½ months-old white breeding Sow Pigs of a small breed; bred by himself.

FARM POULTRY: *Dorking Fowls.*

CAPTAIN WINDHAM HORNBY, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of FIVE SOVEREIGNS, for his 4 months and 2 weeks-old grey Dorking Cock and Two Hens; bred by himself.

JAMES LEWRY, of Hand Cross, near Crawley, Sussex: the Prize of THREE SOVEREIGNS, for his 4 months and 1 week-old Single Comb grey speckled Dorking Cock and two Hens; bred by himself.

James Lewry, of Hand Cross, near Crawley, Sussex: the Prize of Two Sovereigns, for his 3 months-old Single Comb grey speckled Dorking Cock and two Hens; bred by himself.

Thomas Townley Parker, of Astley Hall, near Chorley, Lancashire: the Prize of One Sovereign, for his 4 months and 2 days-old grey speckled Dorking Cock and two Hens; bred by himself.

Captain Windham Hornby, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of Five Sovereigns, for his 1 year and 2 months-old grey Dorking Cock and two Hens; bred by himself.

Captain Windham Hornby, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of Three Sovereigns, for his 1 year 2 months and 2 weeks-old grey Dorking Cock and two Hens; bred by himself.

Viscount Hill, of Hawkstone, near Shrewsbury, Shropshire: the Prize of Two Sovereigns, for his 1 year and 2 months-old grey Dorking Cock and two Hens; bred by himself.

Thomas Townley Parker, of Astley Hall, near Chorley, Lancashire: the Prize of One Sovereign, for his 1 year and 2 months-old and 1 year and 4 months-old grey Dorking Cock and two Hens; bred by himself.

Farm Poultry: *Spanish Fowls.*

Captain Windham Hornby, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of Five Sovereigns, for his about 2 years-old whitefaced Spanish Cock and two Hens; breeder unknown.

Captain Windham Hornby, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of Three Sovereigns, for his about 2 years-old whitefaced Spanish Cock and two Hens; breeder unknown.

W. B. Mapplebeck, of Bull Ring, Birmingham, Warwickshire: the Prize of Two Sovereigns, for his 1 year and 4 months-old black Spanish Cock and two Hens; bred by himself.

J. P. Adams, of Newland, near Malvern, Worcestershire: the Prize of One Sovereign, for his 1 year and 2 months-old black Spanish Cock and two Hens; bred by himself.

Farm Poultry: *Cochin China Fowls.*

Edward Terry, of Aylesbury, Buckinghamshire: the Prize of Five Sovereigns, for his 5 months-old buff Cochin China Cock and two Hens; breeder unknown.

Charles Punchard, of Blunt's Hall, near Haverhill, Suffolk: the Prize of Three Sovereigns, for his 5 months-old light Cochin China Cock and two Hens; bred by himself.

Sarah Rebecca Herbert, of Powick, near Worcester: the Prize of Two Sovereigns, for her 4 months-old white Cochin China Cock and two Hens; bred by herself.

William Cust Gwynne, M.D., of Sandbach, Cheshire: the Prize of One Sovereign, for his 17 weeks and 15 weeks-old grey Shanghais or Brahma Pootra Cochin China Cock and two Hens; bred by himself.

Farm Poultry: *Game Fowls.*

Nathan N. Dyer, of Bredon Manor House, near Tewkesbury, Gloucestershire: the Prize of Three Sovereigns, for his 2 years and 1 month-old black Game Cock and two Hens; bred by himself.

Edward Lowe, of Comberford Flour Mills, near Tamworth, Staffordshire: the Prize of Two Sovereigns, for his 1 year and 2 months-old black-breasted Red Game Cock and two Hens; bred by himself.

Edward Glover, of Olton, near Solihull, Warwickshire: the Prize of One Sovereign, for his 1 year and 1 month-old black-breasted Red Game Cock and two Hens; bred by himself.

Farm Poultry: *Hamburgh Fowls.*

William Ludlam, of Bradford, Yorkshire: the Prize of Three Sovereigns, for his 2 years-old Golden Spangled Hamburgh Cock and two Hens; bred by himself.

Joseph Jennens, of Moseley, near Birmingham, Warwickshire: the Prize of Two Sovereigns, for his 2 years and 4 months-old Silver-spangled Hamburgh Cock and two Hens; breeder unknown.

Thomas Lowe, of Whateley, near Fazeley, Staffordshire: the Prize of One Sovereign, for his 11 months and 1 week-old Silver-pencilled Hamburgh Cock and two Hens; bred by himself.

Farm Poultry: *Malay Fowls.*

Austin Cooper Sayers, of Clanville House, near Andover, Hampshire: the Prize of Three Sovereigns, for his 2 years and 2 months-old Chittagong Malay Cock and two Hens; bred by himself.

Henry Worrall, of Knotty Ash House, near Liverpool, Lancashire: the Prize of Two Sovereigns, for his 1 year 3 months and 1 week-old Malay Cock and two Hens; bred by George Oldham, of Nether Whitacre, Warwickshire.

W. B. Mapplebeck, of Bull Ring, Birmingham, Warwickshire: the Prize of One Sovereign, for his 1 year and 4 months-old Malay Cock and two Hens; bred by himself.

Farm Poultry: *Poland Fowls.*

Christopher Rawson, of the Hurst, near Walton-on-Thames, Surrey: the Prize of Three Sovereigns, for his (age unknown) Silver-spangled Poland Cock and two Hens; breeder unknown.

William Cox, of Brailsford Hall, Derby: the Prize of Two Sovereigns, for his (age unknown) Gold-spangled Cock and two Hens; breeder unknown.

W. G. Vivian, of Singleton, near Swansea, Glamorganshire: the Prize of One Sovereign, for his 13 months-old White Poland Cock and two Hens; breeder unknown.

Farm Poultry: *Turkeys.*

Viscount Hill, of Hawkstone, near Shrewsbury, Shropshire: the Prize of Five Sovereigns, for his 3 years and 2 months and 2 years and 2 months-old American Cock and two Hen Turkeys; bred by himself.

John Fairlie, of Cheveley Park, near Newmarket, Cambridgeshire: the Prize of Three Sovereigns, for his 1 year and 2 months-old English Cock and two Hen Turkeys; bred by himself.

Robert Thomas Head, of The Briars, Alphington, near Exeter, Devonshire: the Prize of Two Sovereigns, for his 1 year and 2 months-old Wild American Cock and two Hen Turkeys; bred by Purnell B. Purnell, of Stancombe Park, near Dursley, Worcestershire.

[The Prize of One Sovereign for the fourth best Cock and two Hen Turkeys, was withheld by the Judges.]

Farm Poultry: *Geese.*

Thomas Townley Parker, of Astley Hall, near Chorley, Lancashire: the Prize of Five Sovereigns, for his 13 weeks-old common Gander and two Geese; bred by himself.

Thomas Townley Parker, of Astley Hall, near Chorley, Lancashire: the Prize of Three Sovereigns, for his 13 weeks-old common Gander and two Geese; bred by himself.

Captain Windham Hornby, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of Two Sovereigns, for his 17 weeks-old Toulouse and English Gander and two Geese; bred by himself.

THOMAS TOWNLEY PARKER, of Astley Hall, near Chorley, Lancashire: the Prize of ONE SOVEREIGN, for his 13 weeks-old common Gander and two Geese; bred by himself.

FARM POULTRY: *Aylesbury Ducks.*

JOHN WESTON, of Oxford Road, Aylesbury, Buckinghamshire: the Prize of THREE SOVEREIGNS, for his 4 months-old Aylesbury Drake and two Ducks; bred by himself.

LYDIA CONSTANTIA STOW, of Bredon, near Tewkesbury, Gloucestershire: the Prize of TWO SOVEREIGNS, for her 4 months and 1 week-old White Aylesbury Drake and two Ducks; bred by herself.

ANN WILCOX, of Nailsea Court, near Bristol, Somersetshire: the Prize of ONE SOVEREIGN, for her 2 months and 1 week old Aylesbury Drake and two Ducks; bred by herself.

FARM POULTRY: *Rouen Ducks.*

HENRY WORRALL, of Knotty Ash House, near Liverpool, Lancashire: the Prize of THREE SOVEREIGNS, for his about 2 years-old Rouen or Rhone Drake and two Ducks; bred by himself.

WILLIAM WEVILL ROWE, of Longbrook, near Milton Abbott, Devonshire: the Prize of TWO SOVEREIGNS, for his 2 years and 1 year-old Rouen Drake and two Ducks; breeder unknown.

CAPTAIN WINDHAM HORNBY, R.N., of Knowsley Cottage, near Prescot, Lancashire: the Prize of ONE SOVEREIGN, for his 1 year and 2 months-old Rouen Drake and two Ducks; bred by himself.

FARM POULTRY: *Ducks of any other variety than Aylesbury or Rouen.*

HENRY SMYTH PIGOTT, of Brockley Court, near Bristol, Somersetshire: the Prize of THREE SOVEREIGNS, for his under 9 weeks-old Black Labrador Drake and Two Ducks: bred by himself.

HENRY SMYTH PIGOTT, of Brockley Court, near Bristol, Somersetshire: the Prize of TWO SOVEREIGNS, for his under 9 weeks-old Black Labrador Drake and two Ducks; bred by himself.

SARAH BUCKLE, of Moat House, Uckington, near Cheltenham, Gloucestershire: the Prize of ONE SOVEREIGN, for her 1 year 1 month and 2 weeks-old Decoy Drake and two Ducks; bred by herself.

Commendations.

ISAAC NIBLETT, of Congre Farm, Filton, Bristol: a white Short-horned Bull "Snowdrop;" bred by Viscount Hill, of Hawkstone, Salop.

EDWARD WILLIAM SMYTHE OWEN, of Condover Hall, Salop: a roan Short-horned In-milk Cow, "Brandy;" bred by himself.

RICHARD STRATTON, of Broad Hinton, Wilts: a roan Short-horned In-milk Heifer, "Matchless the Second;" bred by himself.

EDWARD BATE, of Kelsterton, Flint: a roan Short-horned yearling Heifer, "Queen Bee;" bred by Thomas Birchall, of Ribbleton Hall, Lancashire.

*GEORGE SEXTY, of Aylton, near Ledbury, Herefordshire: a brown and white Hereford Bull, "Inheritor;" bred by John Cooke, of Moreton House, near Hereford.

JOHN MONKHOUSE, of The Stow, Hereford: a red with white-face Hereford Bull, "Madoc;" bred by James Rea, of Monaughty, Radnorshire.

LORD BERWICK, of Cronkhill, Salop: a grey with white face Hereford In-milk and In-calf Cow, "Strawberry;" bred by himself.

*WALTER MAYBERY, of Brecon: a brown and white Hereford In-milk Heifer, "Gwenllian;" bred by himself.

EDWARD WILLIAMS, of Llowes Court, near Hay, S. W.: a brown Hereford In-calf Heifer, "Silver the Second;" bred by himself.

JOHN NAYLOR, of Leighton Hall, near Welshpool: a red and white Hereford yearling Heifer, "Flora;" bred by Thomas Yeld, of Broom, Herefordshire.

JOHN TUCKER, of Yara Farm, Staplegrove, Somerset: a red Devon Bull, "Eclipsea;" bred by John Boucher, of Wiveliscombe, Somerset.

*SAMUEL FARTHING, of Stowey Court, near Bridgewater, Somerset: a red Devon Bull, "Duke of Somerset;" bred by John Knight Farthing, of Stowey Court, Somerset.

THOMAS WEBBER, of Halberton Court, near Tiverton, Devonshire: a red Devon In-calf Cow, "Lilly;" bred by himself.

*WILLIAM M. GIBBS, of Bishops Lydeard, Somerset: a red Devon In-calf Cow, "Daisy;" bred by himself.

*JAMES HOLE, of Knowle House, Dunster, Somerset: a red Devon In-milk Cow, "Lily;" bred by himself.

*JOHN TUCKER, of Yara farm, Staplegrove, Somerset: a red Devon In-calf Cow, "Fancy;" bred by himself.

*WILLIAM M. GIBBS, of Bishops Lydeard, Somerset: a red Devon In-milk Heifer, "Young Fairmaid;" bred by himself.

ABRAHAM UMBERS, of Weston Hall, near Leamington: two Devon In-calf Heifers; bred by himself.

Rev. CECIL SMITH, of Lydeard House, near Taunton: a red Devon yearling Heifer, "Bertha;" bred by himself.

Rev. CECIL SMITH, of Lydeard House, near Taunton: a red Devon yearling Heifer, "Joanna;" bred by himself.

*GEORGE TURNER, of Barton, near Exeter, a red Devon yearling Heifer "Dahlia;" bred by himself.

SAMUEL FARTHING, of Stowey Court, Somerset: a red Devon yearling Heifer; bred by himself.

*JAMES HOLE, of Knowle House, Dunster, Somerset: two red Devon yearling Heifers; bred by himself.

SAMUEL BURBERY, of Wroxhall, near Warwick: a brindled Long-horned In-milk and In-calf Cow, "Woodbine;" bred by himself.

*EDWARD CANE, of Berwick Court, near Lewes, Sussex: a red Sussex yearling Heifer; bred by himself.

JOHN CRUMP, of Grafton, near Tewkesbury, Gloucestershire: a dark brown Agricultural Stallion, "Young Invincible;" bred by John Freeman, of Walcot, near Swindon, Wiltshire.

*THOMAS DUNCKLEY, of Staverton, near Daventry, Northamptonshire: a black Agricultural Stallion, "Waxwork;" bred by himself.

*WILLIAM GREENAWAY, of Even-Swindon, Wiltshire: a grey Agricultural Stallion "Wiltshire Champion;" bred by himself.

WILLIAM WILSON, of Ashbocking, near Ipswich, Suffolk: a chesnut pure Suffolk Agricultural Stallion; bred by Charles Semmen, of Bredfield, near Woodbridge, Suffolk.

*F. LEYBORNE POPHAM, of Littlecott, near Hungerford, Berkshire: a brown Agricultural Stallion "Mendip:" bred by John Grimstead, of Nylands, near Cheddar, Somersetshire.

JOHN RAMSBOTTOM, of Bilham Grange, near Doncaster, Yorkshire: a dark brown Agricultural Stallion, "King of Trumps;" bred by John Laurance, of Hampool, near Doncaster, Yorkshire.

The EARL of JERSEY, of Middleton Stoney, near Bicester, Oxfordshire: a chesnut Suffolk Agricultural Stallion, "The Colonel;" bred by himself.

WILLIAM MELSOME, of Norton Bavant, near Warminster, Wiltshire: a chesnut mixed Suffolk and Wiltshire Agricultural Stallion, "Marquis;" bred by himself.

HENRY WATTS, of Whitminster House, near Stroud, Gloucestershire: a brown Gloucestershire Agricultural Mare, "Diamond," and foal; bred by himself.

LORD ST. JOHN, of Melchbourne, near Higham Ferrers, Northamptonshire: a brown Northamptonshire Agricultural Mare, "Brown," and foal; bred by Thomas Faulkner, of Tiffield, near Towcester, Northamptonshire.

THOMAS EDWARD PAWLETT, of Beeston, near Sandy, Bedfordshire: a Leicester Shearling Ram; bred by himself.

WILLIAM SANDAY, of Holme Pierrepont, near Nottingham: a Leicester Shearling Ram; bred by himself.

*William Sanday, of Holme Pierrepont, near Nottingham: a Leicester Shearling Ram; bred by himself.

John Borton, of Barton-le-Street, Malton, near Yorkshire: two Leicester Shearling Rams; bred by himself.

George Radmore, of Court Hayes, Thorverton, near Cullompton, Devon: a Leicester Shearling Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Sandy, Bedfordshire: four Leicester Rams; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: three Leicester Rams; bred by himself.

*William Sanday, of Holme Pierrepont, near Nottingham: a Leicester Ram; bred by himself.

George Turner, of Barton, near Exeter: a Leicester Ram; bred by himself.

Samuel Umbers, of Wappenbury, near Leamington, Warwickshire: a Leicester Ram, "Black Foot;" bred by himself.

William Abraham, of Barnet-by-le-Wold, near Brigg, Lincolnshire: a pen of Leicester Shearling Ewes; bred by himself.

*Henry Lugar, of Hengrave, near Bury St. Edmunds, Suffolk: a Southdown Shearling Ram; bred by himself.

Jonas Webb, of Babraham, near Cambridge: two Southdown Shearling Rams; bred by himself.

*William Sainsbury, of Manor House, West Lavington, Wiltshire: a Southdown Ram; bred by himself.

*William Rigden, of Hove, near Brighton: a pen of Southdown Shearling Ewes; bred by himself.

The Duke of Richmond, of Goodwood, near Chichester, Sussex: a pen of Southdown Shearling Ewes; bred by himself.

*Lord Walsingham, of Merton Hall, near Thetford, Norfolk: a pen of Southdown Shearling Ewes; bred by himself.

*William Garne, of Aldsworth, near Northleach, Gloucestershire: a Cotswold Shearling Ram; bred by himself.

Edward Handy, of Sevenhampton, near Andoversford, Gloucestershire: an improved Cotswold Shearling Ram; bred by himself.

George Hewer, of Leygore, near Northleach, Gloucestershire: a Cotswold Shearling Ram; bred by himself.

William Cother, of Middle Aston, near Woodstock, Oxon: a Cotswold Shearling Ram; bred by himself.

George Fletcher, of Shipton, near Andoversford, Gloucestershire: two Cotswold Shearling Rams; bred by himself.

*Lord De Mauley, of Hatherop, near Fairford, Gloucestershire: a Cotswold Ram; bred by John Hall, of Coates, near Cirencester, Gloucestershire.

William Garne, of Aldsworth, near Northleach, Gloucestershire: a Cotswold Ram; bred by himself.

*William Lane, of Broadfield Farm, Eastington, near Northleach, Gloucestershire: a Cotswold Ram; bred by himself.

William Garne, of Aldsworth, near Northleach, Gloucestershire: a pen of Cotswold Shearling Ewes; bred by himself.

*George Fletcher, of Shipton, near Andoversford, Gloucestershire: two pens of Cotswold Shearling Ewes; bred by himself.

Thomas Gillett, of Kilkenny, near Witney, Oxfordshire: a pen of Long-Woolled Shearling Ewes; bred by himself.

*John Gillett, of Brize Norton, near Witney, Oxfordshire: a black-faced Short-Woolled Ram; bred by himself.

*Samuel Meire, of Castle Hill, near Much Wenlock, Shropshire: a pen of improved Shropshire Short-Woolled Ewes, with their lambs; bred by himself.

*William Foster, of Kinver Hill Farm, near Stourbridge, Worcestershire: a pen of Shropshire Short-Woolled Shearling Ewes; bred by himself.

R. Brodhurst Hill, of Bach Hall, near Chester: a white Boar, of a small breed; bred by himself.

*Henry Scott Hayward, of Folkington, near Willingdon, Sussex: a white Boar, of a small breed; bred by himself.

THOMAS HORSFALL, of Burley Hall, near Otley, Yorkshire: a white Boar, of a small breed, "Wharfdale Lad;" bred by Stephen Blakeney, of Otley, Yorkshire.

*LORD WENLOCK, of Escrick Park, near York: a white Boar, of a small breed; bred by himself.

R. BRODHURST HILL, of Bach Hall, near Chester, a white Boar, of a small breed; bred by John Brown, of Height, near Wigton, Cumberland.

EDWARD BOWLY, of Siddington House, near Cirencester, Gloucestershire: a black and white Berkshire Breeding Sow, of a large breed; bred by himself.

WILLIAM SANDAY, of Holme Pierrepont, near Nottingham; a white Cumberland Breeding Sow, of a large breed; bred by Moses Cartwright, of Stanton Hill, near Burton-upon-Trent, Staffordshire.

*Rev. CHARLES THOMAS JAMES, of Ermington, near Ivy Bridge, Devonshire: a black Neapolitan and Berkshire Breeding Sow, of a large breed; bred by himself.

*THOMAS HORSFALL, of Burley Hall, near Otley, Yorkshire: a white Breeding Sow, of a large breed, "Zenobia;" bred by John Sugden, of Keighley, Yorkshire.

**GEORGE MANGLES, of Givendale, near Ripon, Yorkshire; a white improved Yorkshire Breeding Sow, of a small breed, "Queen of Diamonds;" bred by himself.

*WILLIAM NORTHEY, of Lake, near Lifton, Devonshire: an improved Leicester Breeding Sow, of a small breed; bred by himself.

*WILLIAM LUDLAM, of Bradford, Yorkshire: a white Breeding Sow, of a pure small breed, "England's Glory;" bred by Edward Hartley, of Woodhouse Carr, near Leeds, Yorkshire.

R. BRODHURST HILL, of Bach Hall, near Chester: a white Breeding Sow, of a small breed, "Lady Wenlock;" bred by John Unthank, near Penrith, Cumberland.

DANIEL LEEMING, of Little Blackwood House, near Halifax, Yorkshire: a white Breeding Sow, of a small breed, "Dina;" bred by Thomas Greenwood, of Hepestall, near Halifax, Yorkshire.

JOHN MOON, of Lapford, near Crediton, Devonshire, a black improved Essex Breeding Sow, of a small breed, "Narcissus;" bred by himself.

SOLOMON ASHTON, of Peter Street, Manchester, Lancashire: a white Breeding Sow, of a pure small breed, "Matchless;" bred by William Edwards, of Deansgate, Manchester.

WILLIAM NORTHEY, of Lake, near Lifton, Devonshire, a pen of black improved Leicester Breeding Sow Pigs; bred by himself.

*VISCOUNT HILL, of Hawkstone, near Shrewsbury, Shropshire: a grey Dorking Cock and two Hens; bred by himself.

*JOHN HITCHMAN, M.D., of Mickleover, near Derby: a speckled single comb Dorking Cock and two Hens; bred by himself.

EDWARD TERRY, of Aylesbury, Buckinghamshire: a light brown or speckled Dorking Cock and two Hens; bred by himself.

W. B. MAPPLEBECK, of Bull Ring, Birmingham, Warwickshire: a double or rose-combed Dorking Cock and two Hens; bred by himself.

*HENRY SMITH, of the Grove, Cropwell Butler, near Bingham, Nottinghamshire: a grey Dorking Cock, and two Hens; bred by Captain Windham Hornby, R.N., of Knowsley Cottage, near Prescot, Lancashire.

*JOHN FAIRLIE, of Cheveley Park, near Newmarket, Cambridgeshire: a single combed grey speckled Dorking Cock, and two Hens; bred by John Baily, of 113, Mount Street, London.

VISCOUNT HILL, of Hawkstone, near Shrewsbury, Shropshire: a grey Dorking Cock and two Hens; bred by himself.

JAMES LEWRY, of Handcross, near Crawley, Sussex: a single comb dark speckled Dorking Cock, and two Hens; bred by himself.

*JAMES LEWRY, of Handcross, near Crawley, Sussex: a single comb dark speckled Dorking Cock, and two Hens; bred by himself.

*THOMAS LYNE, of Malmesbury, Wiltshire: a speckled Dorking Cock and two Hens, the Cock bred by John Alsop, of Sherstone Magna, Wiltshire, and the Hens by Henry Cole, of Malmesbury, Wiltshire.

CHRISTOPHER RAWSON, of the Hurst, Walton-on-Thames, Surrey: a buff Cochin China Cock, and two Hens; bred by himself.

*CHRISTOPHER RAWSON, of the Hurst, Walton-on-Thames, Surrey: a black with white toppings Poland Cock and two Hens; bred by himself.

Anne Frances Vernon, of Barnwood, near Gloucester: a large grey and white domestic Gander, and two Geese; bred by herself.

John Fairlie, of Cheveley Park, near Newmarket, Cambridgeshire: a common English Gander and two Geese; bred by himself.

*Rev. John Herbert, of Leigh Parsonage, near Reigate, Surrey: a grey Gander and two Geese; bred by Ann Tidy, of Ellens Green, Ewhurst, Surrey.

*Robert Glover, of Holt Hall, near Fazeley, Staffordshire: a white Gander, and two Geese; bred by himself.

W. G. K. Breavington, of Vicarage Farm, Heston, near Hounslow, Middlesex: a naturalised English double brooded Gander and two Geese; bred by himself.

[These Commendations are arranged in the order of the numbers of the Certificates to which they refer. The mark (*) signifies "highly commended;" the omission of it, "commended;" by the Judges. The mark (**) signifies "very highly commended."]

IMPLEMENTS.

William Busby, of Newton-le-Willows, Yorkshire, for his Plough best adapted for general purposes . . . . Seven Sovereigns.

William Ball, of Rothwell, Northamptonshire, for his Plough best adapted for Deep-Ploughing . . . . . Seven Sovereigns.

Ransomes and Sims, of Ipswich, for their One-way or Turn-wrest Plough, Seven Sovereigns.

Thomas Glover, of Thrussington, Leicestershire, for his Paring Plough, Five Sovereigns.

Edward Hammond Bentall, of Heybridge, Essex, for his Dynamometer, especially applicable to the traction of Ploughs, and indicating the extent of the work done . . . . Five Sovereigns.

J. and F. Howard and Son, of Bedford, for their Subsoil Pulverizer, Five Sovereigns.

John Whitehead, of Preston, Lancashire, for his Machine for making Draining Tiles or Pipes for agricultural purposes . . Ten Sovereigns.

Harry Winton and Son, of Birmingham, for their Instruments for Hand-use in Drainage . . . . Three Sovereigns.

William Williams, of Bedford, for his Heavy Harrow, Five Sovereigns.

James and Frederick Howard, of Bedford, for their Light Harrow, Five Sovereigns.

Ransomes and Sims, of Ipswich, for their Cultivator, Grubber, and Scarifier, Ten Sovereigns.

Richard Coleman, of Chelmsford, for his Pair-Horse Scarifier, Five Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their Drill for general purposes . . . . Ten Sovereigns.

Richard Hornsby and Son, of Spittlegate Iron Works, Lincolnshire, for their Steerage Corn and Turnip Drill . . Ten Sovereigns.

James Smyth and Son, of Peasenhall, Suffolk, for their Drill for Small Occupations . . . . Five Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their economical Small-occupation Seed and Manure Drill for Flat or Ridged Work, Five Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their Turnip Drill on the Flat . . . . Ten Sovereigns.

Richard Hornsby and Son, of Spittlegate Iron Works, Lincolnshire, for their Turnip Drill on the Ridge . . . Ten Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their Drop Drill, for depositing Seed and Manure . . . . Ten Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their Manure Distributor, Ten Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their Horse Hoe on the Flat . . . . Five Sovereigns.

J. and F. Howard, of Bedford, for their Horse Hoe on the Ridge, Five Sovereigns.

William Crosskill, of Beverley, for his Reaping Machine, on Bell's principle . . . . Twenty Sovereigns.

Thomas Milford, of Thorverton, near Cullompton, Devon, for his One-Horse Cart for general purposes . . . . Five Sovereigns.

William Crosskill, of Beverley, for his Light Waggon for general purposes . . . . Ten Sovereigns.

Clayton, Shuttleworth, and Co., of Stamp End Iron Works, Lincolnshire, for their Portable Steam-Engine, not exceeding 6-horse power, applicable to Thrashing or other agricultural purposes, Twenty Sovereigns.

Richard Hornsby and Son, of Spittlegate Iron Works, Lincolnshire, for their second-best Portable Steam-Engine, not exceeding 6-horse power, applicable to Thrashing or other agricultural purposes, Ten Sovereigns.

Clayton, Shuttleworth, and Co., of Stamp End Iron Works, Lincolnshire, for their Fixed Steam-Engine, not exceeding 8-horse power, applicable to Thrashing or other agricultural purposes, Twenty Sovereigns.

Barrett, Exall, and Andrewes, of Katesgrove Iron Works, Berkshire, for their second-best fixed Steam Engine, not exceeding 8-horse power, applicable to Thrashing or other agricultural purposes, Ten Sovereigns.

Ransomes and Sims, of Ipswich, Suffolk, for their Portable Thrashing Machine, not exceeding 2-horse power, for small occupations, Ten Sovereigns.

Ransomes and Sims, of Ipswich, Suffolk, for their Portable Thrashing Machine, not exceeding 6-horse power, for larger occupations, Fifteen Sovereigns.

Charles Hart, of Wantage, Berkshire, for his Portable Thrashing Machine, not exceeding 6-horse power, with shaker and riddle: to be driven by steam . . . . Twenty Sovereigns.

Clayton, Shuttleworth, and Co., of Lincoln, for their Fixed Thrashing Machine, not exceeding 6-horse power, with straw-shaker, riddle, and winnower, that will best prepare the corn for the finishing dressing-machine, to be driven by steam . . . . Twenty Sovereigns.

Richard Hornsby and Son, of Spittlegate Iron Works, Lincolnshire, for their Corn-dressing Machine . . . . . Five Sovereigns.

Richard Hornsby and Son, of Spittlegate Iron Works, Lincolnshire, for their Corn-dressing Machine, for small occupations, Five Sovereigns.

Clayton, Shuttleworth, and Co., of Lincoln, for their Grinding-Mill for breaking agricultural produce into fine meal . Ten Sovereigns.

E. R. Turner and Co., of Ipswich, for their Linseed and Corn Crusher, Five Sovereigns.

James Cornes, of Barbridge, Cheshire, for his Chaff-Cutter, to be worked by horse or steam power . . . . . . Ten Sovereigns.

James Cornes, of Barbridge, Cheshire, for his Chaff-Cutter, to be worked by hand-power . . . . Five Sovereigns.

Bernhard Samuelson (Successor to the late James Gardner), of Banbury, for his Turnip-Cutter . . . . Five Sovereigns.

Richard Garrett and Son, of Leiston, Suffolk, for their Oil-cake Breaker for every variety of cake . . . . . . Five Sovereigns.

W. N. Nicholson, of Newark, for his Oil-Cake Breaker for thin Cake, Three Sovereigns.

William Prockter Stanley, of Peterborough, for his economical Steaming Apparatus for general purposes . . . Five Sovereigns.

Burgess and Key, of Newgate-street, London, for their American Churn, Three Sovereigns.

R. and J. Reeves, of Bratton, near Westbury, Wiltshire, for their Water-Drill, to drill four Rows of Turnips with Artificial Manures on the flat (special Prize offered by Philip Pusey, Esq.) . Ten Sovereigns.

Richard Garrett and Son, of Leiston Works, Suffolk, for their Revolving Horse Hoe . . . . Silver Medal.

B. Samuelson, of Banbury, for his Digging Machine . Silver Medal.

H. A. Thompson, of Lewes, for his Drainage Level . . Silver Medal.

John Gillam, of Woodstock, for his Seed Cleansing Machine, Silver Medal.

H. Brinsmead, of St. Giles's, near Torrington, for his Patent Straw-Shaker, Silver Medal.

Fowler and Fry, of Bristol, for their Improved Draining Plough, Silver Medal.

Ransomes and Sims, of Ipswich, for their Bean Cutter . Silver Medal.

Smith and Ashby, of Stamford, for their Improved Double-action Haymaking Machine . . . . Silver Medal.

Richard Garrett and Son, of Leiston, Suffolk, for their Fixed Thrashing Machine . . . . Silver Medal.

Clayton, Shuttleworth, and Co., of Lincoln, for their Fixed Thrashing Machine . . . . Silver Medal.

Commendations.

James and Frederick Howard, of Bedford, for their improved Northumberland Ridge or Double-breast Plough.

James Comins, of Southmolton, for his Turn-Wrest Plough for shallow Ploughing and combination as a Moulding Plough.

James and Frederick Howard, of Bedford, for their Plough Blades.

Richard Read, of No. 35, Regent Circus, Piccadilly, London, for his Patent Subsoil Pulverizer.

J. Gray and Co., of Uddingston, near Glasgow, for their Parallel Lever Subsoil Pulverizer.

James and Frederick Howard, of Bedford, for their Patent Jointed Iron Heavy Harrows.

William Williams, of Bedford, for his Patent Four-Beam Diagonal Iron Light Harrows.

*William Crosskill, of the Beverley Iron Works, near Beverley, Yorkshire, for his Improved Norwegian Harrow.

*James Smyth and Son, of Peasenhall, near Yoxford, Suffolk, and of Witham, Essex, for their Drills, generally in reference to the simplicity of their construction and their moderate prices.

*Richard Hornsby and Son, of Spittlegate Iron Works, near Grantham, for their Drill for general purposes.

*Richard Hornsby and Son, of Spittlegate Iron Works, near Grantham, for their Patent Drill for Turnips and Manure on the Flat.

*Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Steerage Corn and Seed Drill.

*Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Combined Seed Sowing and Seed Drilling Machine.

*Marychurch and Son, of Haverfordwest, for their Small Occupation Corn Drill.

William Tasker and George Fowle, of Waterloo Iron Works, near Andover, for their Liquid and Manure Drill.

RICHARD GARRETT and SON, of Leiston Works, near Saxmundham, for their Small Occupation Lever Corn and Seed Drill.

*RICHARD GARRETT and SON, of Leiston Works, near Saxmundham, for their Drill for Turnips and Mangold Wurzel with Manure on the Ridge.

*WILLIAM EAST, of Spalding, Lincolnshire, for his Patent Dropping Machine for Grain.

*HOLMES and SONS, of Norwich, for their Manure Distributor.

*RANSOMES and SIMS, of Ipswich, for their 6-horse Portable Steam-Engine.

*TUXFORD and SONS, of Boston, Lincolnshire, for their Improved Fixed Steam-Engine for general Farm Purposes.

TUXFORD and SONS, of Boston, Lincolnshire, for their Patent Portable Housed Steam-Engine.

RANSOMES and SIMS, of Ipswich, for their 6-horse Portable Steam-Engine.

RANSOMES and SIMS, of Ipswich, for their 8-horse Stationary Horizontal Engine.

RICHARD BACH and Co., of Birmingham, for their 4-horse power Portable Steam-Engine.

RICHARD GARRETT and SON, of Leiston Works, near Saxmundham, Suffolk, for their 5-horse power Portable Steam-Engine.

BARRETT, EXALL, and ANDREWES, of Kates Grove Iron Works, near Reading, Berkshire, for their Patent 6-horse power Portable Steam-Engine.

WILLIAM DRAY and Co., of Swan Lane, London, for their 6-horse power Fixed Steam-Engine.

RICHARD HORNSBY and SON, of Spittlegate Iron Works, near Grantham, Lincolnshire, for their 8-horse power Horizontal Fixture Steam-Engine.

*BURGESS and KEY, of 103, Newgate Street, London, for their Patent Reaper.

WILLIAM DRAY and Co., of Swan Lane, London, for their Reaping Machine.

*RICHARD GARRETT and SON, of Leiston Works, near Saxmundham, Suffolk, for their 4-horse power open Drum Threshing Machine.

The Judges highly commended this Implement specially "For the excellent way in which it is got up, particularly the Drum, which is considered superior in workmanship to any shown in the same class."

*RICHARD GARRETT and SON, of Leiston Works, near Saxmundham, Suffolk, for their 2-horse power Portable Threshing Machine.

The Judges highly commended this Implement specially for "The Drum being the best exhibited in point of workmanship."

*BARRETT, EXALL, and ANDREWES, of Kates Grove Iron Works, near Reading, Berkshire, for their 4-horse power Bolting Threshing Machine.

The Judges highly commended this Implement specially "For the manner in which it did its work, being superior in this respect to any which came under the notice of the Judges."

TUXFORD and SONS, of Boston, Lincolnshire, for their Patent Combined Threshing, Shaking, and Winnowing Machine.

RICHARD HORNSBY and SON, of Spittlegate Iron Works, near Grantham, Lincolnshire, for their 4-horse power Portable Threshing Machine.

*GEORGE HURWOOD, of Ipswich, Suffolk, for his Patent Metal Mill.

*WILLIAM PROCKTER STANLEY, of Peterborough, Northamptonshire, for his Registered Roller Mill.

*HUGH CARSON, of Warminster, Wiltshire, for his Patent Gouge Turnip Cutter.

THOMAS SCRAGG, of Calveley, near Tarporley, Cheshire, for his Single-action Tile Machine.

FOWLER and FRY, of Bristol, for their Brick and Pipe Making Machine.

*JOHN WHITEHEAD, of Preston, Lancashire, for his Patent Socketing Apparatus.

*MAPPLEBECK and LOWE, of Birmingham, for their Set of Patent Pipe Draining Tools.

CHARLES HART, of the Vale of White Horse Iron Works, near Wantage, Berkshire, for his Five-tine Berkshire Cultivator and Pair-horse Scarifier for Light Land.

RICHARD COLEMAN, of Chelmsford, Essex, for his Patent 4-horse Drag Harrow Cultivator or Scarifier for High-ridged Lands.

CHARLES HART, of the Vale of White Horse Iron Works, near Wantage, Berkshire, for his 4-horse Seven-tine Berkshire Cultivator for Light Soils.

WILLIAM BUSBY, of Newton-le-Willows, near Bedale, Yorkshire, for his Ridge Hoe.

EDWARD HILL and Co., of Brierley Hill Iron Works, near Dudley, Worcestershire, for their Registered Wrought-iron Expanding Horse Hoe.

*WILLIAM CROSSKILL, of the Beverley Iron Works, near Beverley, Yorkshire, for his Clod Crusher, for its self-cleaning principle.

WILLIAM CROSSKILL, of the Beverley Iron Works, near Beverley, Yorkshire, for his Patent Serrated Clod Crusher or Wheat Roller.

GIBSON and SON, of St. Andrew's Works, Gallowgate, Newcastle-upon-Tyne, Northumberland, for their "Northumberland Clod Crusher."

GEORGE HANCOCK, of Sandbach, Cheshire, for his Double-action Centrifugal Churn.

RICHARD VICK, of Gloucester, for his Set of long light Cart Harness complete.

JAMES DUNLOP, of Haddington, Scotland, for his Self-adjusting Saddle for Cart or Farm purposes.

JAMES CHADNOR WHITE, of Liverpool Street, Bishopsgate, London, for his Set of Brass and covered mounted Gig Harness.

WILLIAM DRAY and Co., of Swan Lane, London, for their Enamelled Cast-iron Manger and Water-Trough with Rack.

EDWARD HILL and Co., of Brierley Hill Iron Works, near Dudley, Worcestershire, for their Set of Improved Cast-iron Stable Furniture.

WILLIAM DRAY and Co., of Swan Lane, London, for their Cottage Mangle.

BARNARD and BISHOP, of Norwich, for their Cottage Mangle.

EDWARD HILL and Co., of Brierley Hill Iron Works, near Dudley, Worcestershire, for their Wrought-Iron Gate.

EDWARD HILL and Co., of Brierley Hill Iron Works, near Dudley, Worcestershire, for their Patent Weighing Machine.

*JOHN WOOD SHARMAN, of Wellingborough, Northamptonshire, for his Pair of Hand Hay or Corn Drag Rakes.

BARNARD and BISHOP, of Norwich, for their Double Norfolk Pig Trough.

BENJAMIN WRIGHT, of St. Nicholas, near Cardiff, Glamorganshire, for his Strong Sheep-folding Hurdle.

HENRY ATWOOD THOMPSON, of Lewes, Sussex, for his Improved Portable Copper.

JOHN CALE, of Gloucester, for his Slate Milk Cooler.

JAMES WOODS, of Stowmarket, Suffolk, for his Portable Asphalte Cauldron.

SAMUEL NYE and JOHN GILBERT, of 79, Wardour Street, London, for their Patent Mincing Machine.

RICHARD READ, of 35, Regent Circus, Piccadilly, London, for his Patent Double-action Greenhouse Pump.

*WILLIAM DRAY and Co., of Swan Lane, London, for their Screw Lifting Jack.

*The mark * signifies* HIGHLY *commended; the omission of it,* COMMENDED, *by the Judges.*